Multilocation Transshipment Project

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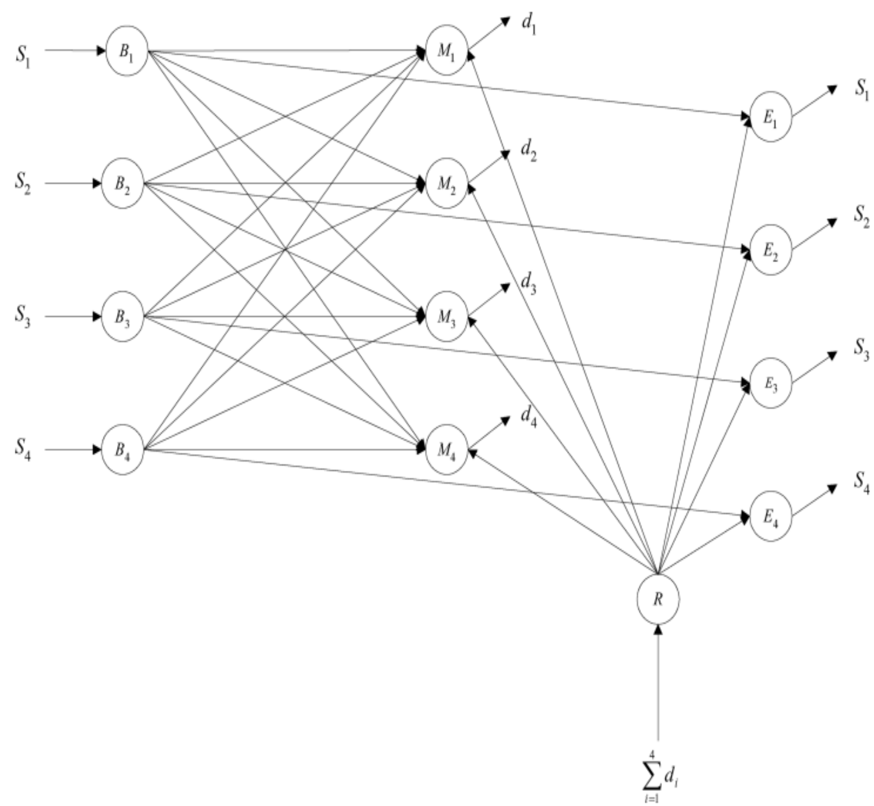
Project Objectives

- Problem Definition
- Assumptions
- Mathematical Formulation
- Algorithm Comparison (SQG vs RSD)
- Timeline

Problem Definition

In the system being studied, there is one supplier which replenishes goods for all the N nonidentical retailers aimed to meet customer demand. Since the system has an infinite horizon, within each single period, replenishments from the supplier were placed in the previous period in order to satisfy backlog and increase the inventory level. After the occurence of the demand, transshipments are made to satisfy the unreached demand.



Problem Assumption

- **Assumption**
  - **Stores have a maximum capacity that cannot be exceeded**
  - **Cost of transshipment from retailers vary based on distance**
  - **Holding Cost and Shortage Cost are weighted based on demand**
  - **The demand distribution at each retailer in a period is known and stationary over time**

Problem Formulation

Objective Function:

$$\min \sum_i c_i \cdot s_i + \sum_i h_i e_i + \sum_{i \neq j} ft \cdot c_{ij} t_{ij} + \sum_i p_i r_i$$

Constraints:

$$f_i + \sum_{i \neq j} t_{ij} + e_i = s_i\,, \quad \forall i \qquad (1a)$$

$$f_i + \sum_{i \neq j} t_{ji} + r_i = d_i\,, \quad \forall i \qquad (1b)$$

$$\sum_i r_i + \sum_i q_i = \sum_{i \neq j} d_i\,, \quad \forall i \qquad (1c)$$

$$e_i + q_i = s_i\,, \quad \forall i \qquad (1d)$$

$$e_i + d_i \leq m_i\,, \forall i \qquad (1e)$$

$$s_i - r_i \leq m_i\,, \forall i \qquad (1f)$$

$$e_i, f_i, q_i, r_i, s_i, t_{ij} \geq 0, \forall i, j.$$

Decision Variables:

- $e_i =$ *ending inventory held at retailer i.*
- $f_i =$ *stock at retailer i used to satisfy demand at retailer i.*
- $q_i =$ *inventory at retailer i increased through replenishment.*
- $r_i =$ *amount of shortage met after replenishment at retailer i.*
- $t_{ij} =$ *stock at retailer i used to meet demand at retailer j, using the transshipment option.*

Objective Function Data:

- $h_i =$ *unit cost of holding inventory at retailer i.*
- $c_{ij} =$ *distances from retailer i to j.*
- $c_i =$ *replenishment cost per unit at retailer i.*
- $p_i =$ *penalty cost for shortage at retailer i.*
- $ft =$ *fixed unit cost of transshipment.*
- $m_i =$ *maximum capacity at retailer i.*
- $s_i =$ *replenishment shipped to retailer i.*

Problem Formulation

- Redefine cost vectors based on demand and distance
  - Larger demand = Higher Shortage Cost + Lower Holding Cost
  - Cost from Retailer i to Retailer j = Fixed Cost * Distance between Retailer i and Retailer j
    - h_i = unit cost of holding inventory at retailer i.
    - c_{ij} = unit cost of transshipment from retailer i to j.
    - p_i = penalty cost for shortage at retailer i.

- Additional Constraints

$$e_i + d_i \leq m_i, \forall i \qquad (1e)$$

$$s_i - r_i \leq m_i, \forall i \qquad (1f)$$

Comparison

- Model Comparison
  - Original Model from the paper (Zhao & Sen 2006)
  - Updated Model with new cost vectors and constraints
- Algorithm Comparison
  - SD vs SQG

Timeline

Objectives	To-do List	Estimated Date
Problem Definition	Finalize Problem Definition	3/8
Data Collection + Modeling	Obtain dataset, derive new cost vectors, set up optimization models	3/15
SD + SQG	Code SQG Algorithm and run models using both SD and SQG	3/22
Preliminary Portfolio	Compare results and write preliminary draft	3/31