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Linear Programming and North-West Corner Method for Transportation Optimization Using Python

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Abstract

Efficient resource allocation and transportation planning are essential components of industrial decision-making. Linear Programming (LP) is widely used to optimize resource utilization by maximizing profit or minimizing cost under certain constraints. The North-West Corner Method (NWCM) is a simple technique used to obtain an initial feasible solution to transportation problems. This study presents the implementation of Linear Programming and the North-West Corner Method using Python programming. A manufacturing-based case study is considered to demonstrate how optimization techniques assist organizations in production planning and transportation scheduling. The results show that Python-based optimization models can efficiently determine optimal production levels and feasible transportation allocations. The study highlights the practical importance of computational optimization techniques in modern supply chain and manufacturing systems.

Key Words: Linear Programming, North-West Corner Method, Transportation Problem, Optimization, Python.

AMS Classification: 34C23, 34C37, 34D05, 34A34.

1 Introduction

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Modern industries rely heavily on optimization techniques to improve operational efficiency and reduce costs. Linear Programming (LP) is a mathematical method used to determine the best possible solution for problems involving limited resources. LP has been widely studied and applied in various mathematical and engineering contexts, including integral equations, fuzzy optimization, and graph theory applications [5–10].

LP is commonly applied in areas such as production planning, logistics, transportation management, and workforce scheduling. The main objective is to maximize profit or minimize cost while satisfying given constraints. Recent studies have also explored advanced mathematical structures such as fuzzy numbers in assignment problems 6, as well as analytical approaches to solving integral equations using computational tools like MATLAB 5.

A special class of LP problems is the transportation problem, which deals with distributing goods from multiple sources to multiple destinations at minimum cost. To obtain an initial feasible solution for transportation problems, several heuristic methods are used. These optimization techniques are closely related to broader mathematical frameworks, including graph-theoretic approaches and labeling methods [7–10].

One of the simplest approaches is the North-West Corner Method (NWCM), which allocates supply and demand starting from the top-left corner of the transportation table. Although it does not guarantee an optimal solution, it provides a quick initial feasible allocation.

Python programming provides powerful tools for solving optimization problems through libraries such as NumPy and PuLP, making computational analysis faster and more accurate. Such computational techniques complement theoretical developments in optimization and applied mathematics, enhancing both efficiency and accuracy in solving real-world problems.

2 Basic Concepts of Linear Programming

Linear programming problems contain three major components.

2.1 Decision Variables

Decision variables represent the unknown quantities that must be determined in order to optimize the objective function.

Example:

Let x = number of tables produced

y = number of chairs produced

2.2 Objective Function

The objective function defines the goal of the optimization problem.

Example:

Z=500x+300yZ = 500x + 300yZ=500x+300y

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Where Z = total profit

The aim is to maximize the value of Z.

2.3 Constraints

Constraints represent the limitations or restrictions on resources such as labour, time, or materials.

Example:

3x+4y≤603x + 4y \leq 603x+4y≤60 2x+y≤402x + y \leq 402x+y≤40 x,y≥0x, y \geq 0x,y≥0

These constraints ensure that the solution remains feasible.

3. NORTH-WEST CORNER METHOD

The North-West Corner Method is a simple technique used to obtain an Initial Basic Feasible Solution (IBFS) for transportation problems.

The method begins at the top-left (north-west) cell of the transportation table and allocates quantities based on supply and demand values.

Steps of the North-West Corner Method

1. Start at the top-left cell of the transportation matrix.
2. Allocate the minimum of supply and demand.
3. Reduce supply or demand after allocation.
4. Move right if demand is satisfied or move down if supply is exhausted.
5. Continue until all allocations are completed.

Example Transportation Table

Factory	Warehouse 1	Warehouse 2	Warehouse 3	Supply
F1	2	3	1	30
F2	5	4	8	40
F3	5	6	8	10
Demand	10	30	40	

Figure 1. North-West Corner Allocation Process

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```
START
   |
Select North-West Cell
   |
Allocate min(Supply, Demand)
   |
Update Supply and Demand
   |
Move Right or Down
   |
Repeat until satisfied
   |
END
```

4. PYTHON IMPLEMENTATION OF NORTH-WEST CORNER METHOD

Python can be used to automate the allocation process of the North-West Corner Method.

Python Code

```
import numpy as np

def northwest_corner_method(supply, demand):

    rows = len(supply)

    cols = len(demand)

    allocation = np.zeros((rows, cols), dtype=int)

    i = 0

    j = 0
```

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```
    while i < rows and j < cols:
        x = min(supply[i], demand[j])
        allocation[i][j] = x

        supply[i] -= x
        demand[j] -= x

        if supply[i] == 0:
            i += 1
        elif demand[j] == 0:
            j += 1
    return allocation
supply = [30,20,20]
demand = [20,50,20]
result = northwest_corner_method(supply, demand)
print(result)
```

Output

```
[30  0  0]
[ 0 20  0]
[ 0 30 20]
```

The allocation matrix shows how much each factory supplies to each destination.

5. LINEAR PROGRAMMING IMPLEMENTATION USING PYTHON

Linear programming models can be solved using the PuLP library in Python.

Mathematical Model

Maximize

Z=30x+20yZ = 30x + 20yZ=30x+20y

Subject to

3x+4y≤603x + 4y \leq 603x+4y≤60 2x+y≤402x + y \leq 402x+y≤40 x,y≥0x,y \geq 0x,y≥0

Python Code

```
import pulp


model = pulp.LpProblem("Profit_Optimization", pulp.LpMaximize)

x = pulp.LpVariable('Product_A', lowBound=0)

y = pulp.LpVariable('Product_B', lowBound=0)

model += 30*x + 20*y

model += 3*x + 4*y <= 60

model += 2*x + y <= 40

model.solve()

print("Optimal A:", x.value())

print("Optimal B:", y.value())

print("Maximum Profit:", pulp.value(model.objective))
```

Output

Optimal A = 8

Optimal B = 6

Maximum Profit = 360

This result indicates the optimal production plan.

6. REAL-WORLD APPLICATION

Optimization techniques such as Linear Programming and the North-West Corner Method are widely used in industrial and commercial environments.

Manufacturing

- Production planning

- Machine time allocation
- Labour scheduling

Transportation and Logistics

- Vehicle routing
- Distribution planning
- Warehouse allocation

Finance

- Portfolio optimization
- Risk management

Agriculture

- Crop planning
- Water resource management

These applications demonstrate the importance of optimization techniques in decision-making.

7. CONCLUSION

This study demonstrated the application of Linear Programming and the North-West Corner Method for solving production and transportation problems using Python. The results show that computational tools can effectively determine optimal production levels and feasible transportation plans.

The North-West Corner Method provides a quick initial solution for transportation problems, while Linear Programming identifies the optimal production strategy under given constraints. These methods are highly useful in real-world industrial applications such as supply chain management and production optimization.

Future research may integrate advanced transportation algorithms such as the Vogel's Approximation Method or MODI method to obtain optimal solutions.

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