## Business Optimization Using Linear Programming

Problem: Maximize profit from the production of two products (A and B) using two machines with limited time.

## Problem Data

|  |  |  |  |
| --- | --- | --- | --- |
| Machine | Product A Time (hrs) | Product B Time (hrs) | Total Available Time (hrs) |
| Machine 1 | 3 | 2 | 120 |
| Machine 2 | 2 | 1 | 100 |

Profit per unit: Product A = $40, Product B = $30

## Mathematical Model

Let x = number of units of Product A

Let y = number of units of Product B

Objective: Maximize Z = 40x + 30y

Subject to:

3x + 2y ≤ 120 (Machine 1 constraint)

2x + y ≤ 100 (Machine 2 constraint)

x, y ≥ 0

## Python Code (Google Colab Compatible)

# Install PuLP  
!pip install pulp  
  
# Import Libraries  
from pulp import LpMaximize, LpProblem, LpVariable, lpSum, value, LpStatus  
import matplotlib.pyplot as plt  
import numpy as np  
  
# Define Problem  
model = LpProblem("Maximize\_Profit", LpMaximize)  
x = LpVariable("Product\_A", lowBound=0)  
y = LpVariable("Product\_B", lowBound=0)  
model += 40 \* x + 30 \* y  
model += 3 \* x + 2 \* y <= 120  
model += 2 \* x + y <= 100  
  
# Solve  
model.solve()  
  
# Results  
print("======== Optimization Result ========")  
print(f"Status: {LpStatus[model.status]}")  
print(f"Optimal units of Product A: {x.varValue}")  
print(f"Optimal units of Product B: {y.varValue}")  
print(f"Maximum Profit: ${value(model.objective)}")  
  
# Machine Time Used  
used\_machine\_1 = 3 \* x.varValue + 2 \* y.varValue  
used\_machine\_2 = 2 \* x.varValue + y.varValue  
print(f"Machine 1 Time Used: {used\_machine\_1}/120")  
print(f"Machine 2 Time Used: {used\_machine\_2}/100")  
  
# Visualization (Optional)  
x\_vals = np.linspace(0, 50, 400)  
y1 = (120 - 3 \* x\_vals) / 2  
y2 = (100 - 2 \* x\_vals)  
  
plt.figure(figsize=(10,6))  
plt.plot(x\_vals, y1, label='3x + 2y ≤ 120')  
plt.plot(x\_vals, y2, label='2x + y ≤ 100')  
plt.fill\_between(x\_vals, np.minimum(y1, y2), where=(y1>0) & (y2>0), color='lightblue', alpha=0.5)  
plt.plot(x.varValue, y.varValue, 'ro', label='Optimal Solution')  
plt.xlabel('Product A')  
plt.ylabel('Product B')  
plt.title('Feasible Region and Optimal Solution')  
plt.legend()  
plt.grid(True)  
plt.xlim(0, 50)  
plt.ylim(0, 50)  
plt.show()