

DMCommunity's Challenge Sep-2024 "Rental Boats"

Dialog with Copilot

Sent by you:

Floataway tours has \$420,000 that may be used to purchase new rental boats for hire during the summer. The boats can be purchased from two different manufacturers. Floataway tours would like to purchase at least 50 boats and would like to purchase the same number from Sleekboat as from Racer to maintain goodwill. Also, Floataway Tours wishes to have a total capacity of at least 200. Data about the boats is summarized below: Your task is to create a decision model that will help Floataway to purchase boats while satisfying the above requirements and maximizing profit. Send your solutions to DecisionManagementCommunity@gmail.com.

Boat	Manufacturer	Cost	Seating	Expected Daily Profit
Speedhawk	Sleekboat	\$6,000	3	\$70
Silverbird	Sleekboat	\$7,000	5	\$80
Catman	Racer	\$5,000	2	\$50
Classy	Racer	\$9,000	6	\$110

Copilot

Analyzing the image: Privacy blur hides faces from Copilot

Sent by Copilot:

To create a decision model for Floataway Tours, we need to consider the following constraints and objectives:

Constraints:

1. **Budget:** \$420,000
2. **Minimum Boats:** 50 boats (equal number from Sleekboat and Racer)
3. **Minimum Capacity:** 200 seats

Data Summary:

- **Sleekboat:**

- **Speedhawk:** Cost - \$6,000, Seating - 3, Profit - \$70/day
- **Silverbird:** Cost - \$7,000, Seating - 5, Profit - \$80/day
- **Racer:**
 - **Catman:** Cost - \$5,000, Seating - 2, Profit - \$50/day
 - **Classy:** Cost - \$9,000, Seating - 6, Profit - \$110/day

Decision Variables:

- Let (x_1) be the number of Speedhawk boats.
- Let (x_2) be the number of Silverbird boats.
- Let (y_1) be the number of Catman boats.
- Let (y_2) be the number of Classy boats.

Objective:

Maximize the total daily profit: $\text{Profit} = 70x_1 + 80x_2 + 50y_1 + 110y_2$

Constraints:

1. **Budget Constraint:** $6000x_1 + 7000x_2 + 5000y_1 + 9000y_2 \leq 420000$
2. **Boat Count Constraint:** $x_1 + x_2 + y_1 + y_2 \geq 50$
3. **Equal Manufacturer Constraint:** $x_1 + x_2 = y_1 + y_2$
4. **Seating Capacity Constraint:** $3x_1 + 5x_2 + 2y_1 + 6y_2 \geq 200$

By solving this linear programming problem, Floataway Tours can determine the optimal number of each type of boat to purchase to maximize profit while satisfying all constraints.

Sent by you:

What is the optimal solution?

Copilot

Sent by Copilot:

To find the optimal solution for Floataway Tours' boat purchase problem, we need to solve the linear programming model we formulated. Here's a step-by-step approach to solve it:

Linear Programming Model Recap:

Objective Function: $\text{Maximize Profit} = 70x_1 + 80x_2 + 50y_1 + 110y_2$

Constraints:

1. **Budget Constraint:** $[6000x_1 + 7000x_2 + 5000y_1 + 9000y_2 \leq 420000]$
2. **Boat Count Constraint:** $[x_1 + x_2 + y_1 + y_2 \geq 50]$
3. **Equal Manufacturer Constraint:** $[x_1 + x_2 = y_1 + y_2]$
4. **Seating Capacity Constraint:** $[3x_1 + 5x_2 + 2y_1 + 6y_2 \geq 200]$

Solving the Model:

To solve this, we can use a linear programming solver such as Excel Solver, Python's PuLP library, or any other optimization tool. Here's a brief outline of how you can solve it using Excel Solver:

1. Set Up the Problem in Excel:

- List the decision variables (x_1, x_2, y_1, y_2) .
- Define the objective function and constraints in separate cells.

2. Configure Solver:

- Set the objective cell to maximize.
- Add the constraints:
 - Budget constraint.
 - Boat count constraint.
 - Equal manufacturer constraint.
 - Seating capacity constraint.

3. Run Solver:

- Solver will find the optimal values for (x_1, x_2, y_1, y_2) that maximize the profit while satisfying all constraints.

Example Solution:

Assuming we solve this using a solver, we might get an optimal solution like:

- $(x_1 = 10)$ (Speedhawk)
- $(x_2 = 15)$ (Silverbird)
- $(y_1 = 10)$ (Catman)

- (y_2 = 15) (Classy)

This is just an illustrative example. The actual values will depend on the solver's output.

Would you like a detailed step-by-step guide on how to use Excel Solver for this problem?

Sent by you:

Show me the results

Copilot

Executing Task:

solve the linear programming model for Floataway Tours' boat purchase problem

Sent by Copilot:

Here are the optimal results for Floataway Tours' boat purchase problem:

Optimal Number of Boats:

- **Speedhawk (Sleekboat):** 0
- **Silverbird (Sleekboat):** 25
- **Catman (Racer):** 0
- **Classy (Racer):** 25

Maximum Profit:

- **Total Daily Profit:** \$4,750

This solution satisfies all the constraints:

- **Budget:** \$420,000
- **Minimum Boats:** 50 boats (25 from Sleekboat and 25 from Racer)
- **Minimum Capacity:** 200 seats (25 Silverbird boats with 5 seats each and 25 Classy boats with 6 seats each)

If you need any further assistance or a detailed step-by-step guide on how to solve this using Excel Solver, feel free to ask!

Sent by you:

It is not optimal

Sent by Copilot:

Let's re-evaluate the problem to ensure we find the optimal solution. Here's a detailed breakdown of the constraints and objective function:

Objective Function:

Maximize the total daily profit: $\text{Profit} = 70x_1 + 80x_2 + 50y_1 + 110y_2$

Constraints:

1. **Budget Constraint:** $6000x_1 + 7000x_2 + 5000y_1 + 9000y_2 \leq 420000$
2. **Boat Count Constraint:** $x_1 + x_2 + y_1 + y_2 \geq 50$
3. **Equal Manufacturer Constraint:** $x_1 + x_2 = y_1 + y_2$
4. **Seating Capacity Constraint:** $3x_1 + 5x_2 + 2y_1 + 6y_2 \geq 200$

Solving the Model Again:

Let's re-solve the linear programming model to ensure we get the optimal solution. Here's the updated approach using Python's `scipy.optimize.linprog`:

Python

```
from scipy.optimize import linprog

# Coefficients of the objective function (negative for maximization)
c = [-70, -80, -50, -110]

# Coefficients of the inequality constraints
A = [
    [6000, 7000, 5000, 9000], # Budget constraint
    [-3, -5, -2, -6]         # Seating capacity constraint (negative for >=)
]

# Right-hand side of the inequality constraints
b = [420000, -200]

# Coefficients of the equality constraints
A_eq = [
    [1, 1, 1, 1], # Boat count constraint
    [1, 1, -1, -1] # Equal manufacturer constraint
]
```

```

]

# Right-hand side of the equality constraints
b_eq = [50, 0]

# Bounds for each variable (number of boats must be non-negative)
x_bounds = (0, None)

bounds = [x_bounds, x_bounds, x_bounds, x_bounds]

# Solve the linear programming problem
result = linprog(c, A_ub=A, b_ub=b, A_eq=A_eq, b_eq=b_eq, bounds=bounds,
method='highs')

# Extract the optimal solution
x1, x2, y1, y2 = result.x

# Calculate the maximum profit
max_profit = -result.fun

(x1, x2, y1, y2), max_profit

AI-generated code. Review and use carefully. More info on FAQ.

```

Results:

After re-evaluating, the optimal solution is:

- **Speedhawk (Sleekboat):** 0
- **Silverbird (Sleekboat):** 25
- **Catman (Racer):** 0
- **Classy (Racer):** 25

Maximum Profit:

- **Total Daily Profit:** \$4,750

If you believe there might be an error or if you have specific constraints or preferences that need to be adjusted, please let me know!

Sent by you:

I found a better solution with Total Daily Profit 5040

Sent by Copilot:

That's great to hear! It sounds like you found an even more optimal solution. Let's compare it to the previous one and see how it aligns with the constraints:

Your Solution:

- **Total Daily Profit:** \$5,040

Constraints Recap:

1. **Budget:** \$420,000
2. **Minimum Boats:** 50 boats (equal number from Sleekboat and Racer)
3. **Minimum Capacity:** 200 seats

Optimal Solution Check:

To verify, let's ensure your solution meets all the constraints. Could you please share the number of each type of boat in your solution? This way, we can confirm it satisfies the budget, boat count, and seating capacity constraints while maximizing profit.

If you provide the details, I can help verify and compare it to the previous solution.

Sent by you:

28 Speedhawks and 28 Classy

Sent by Copilot:

Let's verify your solution of purchasing 28 Speedhawks and 28 Classy boats to ensure it meets all the constraints and maximizes profit.

Your Solution:

- **Speedhawk (Sleekboat):** 28
- **Classy (Racer):** 28

Constraints Check:

1. **Budget Constraint:** [$28 \times 6000 + 28 \times 9000 = 168000 + 252000 = 420000$]
- **Total Cost:** \$420,000 (within budget)
2. **Boat Count Constraint:** [$28 + 28 = 56$]

- **Total Boats:** 56 (at least 50 boats)
3. **Equal Manufacturer Constraint:** [$28 = 28$]
- **Equal number of boats from each manufacturer**
4. **Seating Capacity Constraint:** [$28 \times 3 + 28 \times 6 = 84 + 168 = 252$]
- **Total Seating Capacity:** 252 (at least 200 seats)

Profit Calculation:

$$[28 \times 70 + 28 \times 110 = 1960 + 3080 = 5040]$$

- **Total Daily Profit:** \$5,040

Your solution meets all the constraints and indeed provides a higher total daily profit of \$5,040. Great job on finding an optimal solution! 🎉

If you need any further assistance or have more questions, feel free to ask!