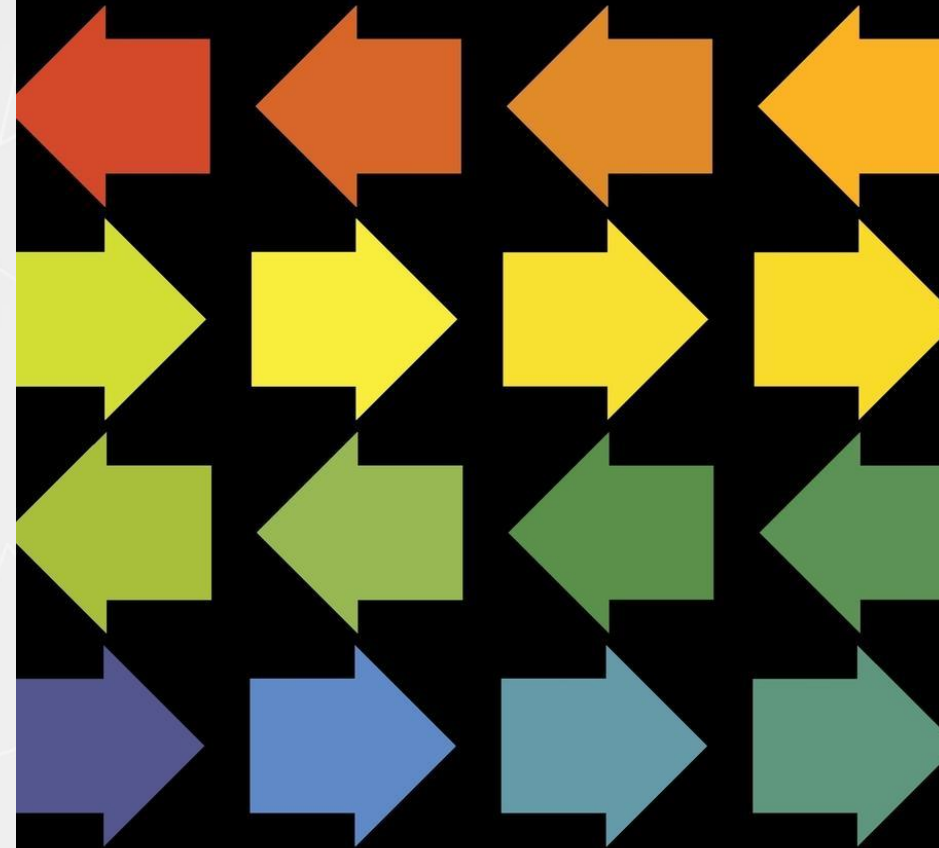


Introduction to linear programming

The Furniture Factory problem

An Illustrated Guide to Linear Programming



Saul I. Gass

The Furniture Factory Problem

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The data scientist using machine learning techniques predicts that the selling price of a chair is \$45 and the selling price of a table is \$80 dollars.

```

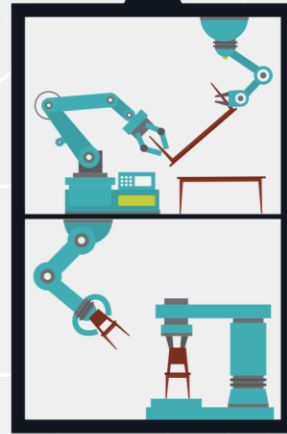
static void StartScreen(void *Context)
{
    // ...
}

static void EndScreen(void *Context)
{
    // ...
}

// ...

```

WBS	Task	Lead	Start	Find	Work day's	% Done	Cal day's	Col of
1	(Category)		3/08/2018	3/12/2018	120	28%	35	k
1.1	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.2	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.3	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.4.1	Lorem ipsum ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.4.2	Lorem ipsum	PS	3/08/2018	3/12/2018	120	28%	35	k
1.5	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.6.1	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
1.7	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
2	(Category)		3/08/2018	3/12/2018	120	28%	35	k
2.1	Lorem ipsum ipsum		3/08/2018	3/12/2018	120	28%	35	k
2.2	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
2.3.3	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
2.4	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
2.5	Lorem ipsum ipsum	AW	3/08/2018	3/12/2018	120	28%	35	k
2.6	Lorem ipsum	JC	3/08/2018	3/12/2018	120	28%	35	k
2.7	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k
3	(Category)		3/08/2018	3/12/2018	120	28%	35	k
3.1	Lorem ipsum	JM	3/08/2018	3/12/2018	120	28%	35	k
3.2	Lorem ipsum	GS	3/08/2018	3/12/2018	120	28%	35	k
3.3.1	Lorem ipsum ipsum	PS	3/08/2018	3/12/2018	120	28%	35	k
3.4	Lorem ipsum ipsum	MS	3/08/2018	3/12/2018	120	28%	35	k
3.5	Lorem ipsum	AC	3/08/2018	3/12/2018	120	28%	35	k
3.6	Lorem ipsum		3/08/2018	3/12/2018	120	28%	35	k





The Furniture Factory Problem

A data scientist is in charge of developing the weekly production plan of two key products that the furniture factory makes: chairs and tables.

The data scientist using machine learning techniques predicts that the selling price of a chair is \$45 and the selling price of a table is \$80 dollars.

- **There are two critical resources in the production of chairs and tables:**
 - Mahogany (measured in board square-feet) and labor (measured in work hours).
 - There are 400 units of mahogany available at the beginning of each week.
 - There are 450 units of labor available during each week.



= 5



10hrs.



= 20



15 hrs.



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 - Mahogany (measured in board square-feet) and labor (measured in work hours).
 - There are 400 units of mahogany available at the beginning of each week.
 - There are 450 units of labor available during each week.
- **The data scientist estimates that**
 - One chair requires 5 units of mahogany and 10 units of labor.
 - One table requires 20 units of mahogany and 15 units of labor.
- **The marketing department has told the data scientist that ALL the production of chairs and tables can be sold.**

Problem statement:

What is the Production Plan that maximizes total revenue?



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The Furniture Factory Problem... 2

DATA	CHAIR	TABLE	CAPACITY
	5 units	20 units	400 units
	10 hours	15 hours	450 hours
	\$45	\$80	

The data of the furniture problem can be summarized in the following table:

- To determine a Production Plan, we need to decide how many chairs and tables to make in order to maximize total revenue, while satisfying resources constraints.
- This problem has two decision variables:
 - x_1 : number of chairs to produce.
 - x_2 : number of tables to produce.
 - The number of chairs and tables to produce should be a non-negative number. That is, $x_1, x_2 \geq 0$.

Note: for the moment, we will assume we can produce and sell fractional quantities of a chair or table. In chapter 2 of these videos series we show how to tackle mathematical programming problems where you require that the decision variables must be integer numbers.

- If we would know the value of the amount of chairs to produce (x_1), then since each chair generates \$45, the total revenue generated by the production of chairs can be determined by the term $45x_1$ ($45 \cdot x_1$).
- Similarly, the total revenue generated by the production of tables can be determined by the term $80x_2$ ($80 \cdot x_2$).
- Consequently, the total revenue generated by the production plan can be determined by the following equation.

• **Revenue = $45x_1 + 80x_2$**

The Furniture Factory Problem... 2

The data of the furniture problem can be summarized in the following table:

 DATA	 CHAIR	 TABLE	 CAPACITY
	5 units	20 units	400 units
	10 hours	15 hours	450 hours
	\$45	\$80	

- The Production Plan is constrained by the amount of resources available.
- How do we ensure that the production plan does not consume more mahogany than the amount of mahogany available?
- If we decide to produce x_1 number of chairs, then the total amount of mahogany consumed by the production of chairs is $5x_1$ ($5 \times x_1$).
- Similarly, if we decide to produce x_2 number of tables, then the total amount of mahogany consumed by the production of tables is $20x_2$ ($20 \times x_2$).
- Hence, the total consumption of mahogany by the production plan determined by the values of x_1 and x_2 is $(5x_1 + 20x_2)$. However, the consumption of mahogany by the production plan cannot exceed the amount of mahogany available. We can express these ideas in the following constraint:

$$5x_1 + 20x_2 \leq 400$$

The Furniture Factory Problem... 2

The data of the furniture problem can be summarized in the following table:

 DATA	 CHAIR	 TABLE	 CAPACITY
	5 units	20 units	400 units
	10 hours	15 hours	450 hours
	\$45	\$80	

- The production plan is constrained by the amount of resources available.
- In similar fashion, we can formulate the constraint for labor resources.
- The total amount of labor resources consumed by the production of chairs is 10 labor units multiplied by the number of chairs produced, that is $10x_1$ ($10 \cdot x_1$).
- The total amount of labor resources consumed by the production of tables is 15 labor units multiplied by the number of tables produced, that is $15x_2$ ($15 \cdot x_2$).
- Therefore, the total consumption of labor resources by the production plan determined by the values of x_1 and x_2 is $(10x_1 + 15x_2)$. This labor consumption cannot exceed the labor capacity available. Hence, this constraint can be expressed as follows:

$$10x_1 + 15x_2 \leq 450.$$

The Furniture Factory Problem... 2

The data of the furniture problem can be summarized in the following table:

 DATA	 CHAIR	 TABLE	 CAPACITY
	5 units	20 units	400 units
	10 hours	15 hours	450 hours
	\$45	\$80	

- The furniture problem formulation as a linear programming (LP) problem is

(1.0). Max revenue = $45x_1 + 80x_2$

(2.0) $5x_1 + 20x_2 \leq 400$ Units of mahogany capacity

(3.0). $10x_1 + 15x_2 \leq 450$ Labor hours capacity

$x_1, x_2 \geq 0$ Non – negativity

The Furniture Factory Problem... 2

The data of the furniture problem is

 DATA	 CHAIR	 TABLE	 CAPACITY
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	\$45	\$80	