# PRODUCTION MANAGEMENT

## Problem Statement

Determining the optimal allocation of such resources as materials, machines, manpower, etc. by a firm and to determine the optimal product- mix to maximize its revenue.


**PRESENTED BY:**

AKASH SRIVASTAVA - 18ucs142
CHIRAG TEJWANI - 18ucs088
PRIYANSHU JAIN - 18ucs230
SANYAM JAIN - 18ucs204
SIDDHARTH SHARMA - 18ucs215
SHUBHAM TIBREWAL - 18ucs035
YASH BAHETI - 18ucs226

# Overview

The project is about biscuit production and optimizing various parameters using different optimization techniques.

# Problem Description

A firm produces biscuits of two types which it then sells through various retail stores and through online chains. A biscuit is mainly constituted of following things: *(i) Flour, (ii) Sugar* and some other ingredients like emulsifiers, milk, butter, etc. which are grouped together as *(iii) Other Ingredients*.

A packet of type A biscuit requires 100 grams of flour, 100 grams of sugar and 25 grams of other ingredients. On the other hand, one packet of type B biscuit requires 200 grams of flour, 125 grams of sugar and 125 grams of other ingredients. For the production, 4 different machinery sets are being used, machine A for kneading the dough, machine B for baking, machine C for refrigeration and machine D for packing with workers working in shifts of 8 hours for maintenance and operation of machines

It is possible to optimize **three parameters** and hence we obtain three objective functions which are as follows:-

1.) Maximizing the total profit where the profit for Type A biscuits is 1 rupee per packet and for Type B biscuits is 2 rupees per packet.
2.) Optimizing the machinery management as the machines can only function for limited hours in one go.
3.) Minimizing the cost associated with manpower according to production needs.

**1.)** Maximizing the total profit where the profit for Type A biscuits is 1 rupee per packet and for Type B biscuits is 2 rupees per packet.

Objective function:

Maximize $z= x_1 + 2x_2$

Amount available(per day)

Total amount of flour available : 100 kg

Total amount of sugar available : 60 kg

Total amount of other ingredients available : 20 kg

Let $x_1$ denote the number of packets of Type A biscuits

Let $x_2$ denote the number of packets of Type B biscuits

As we know from the problem description the amount of different ingredients required for Type A and Type B biscuits, the constraints are as follows:

**Constraints:**

$100x_1 +200x_2 <= 100000$

$25x_1+100x_2 <=20000$

$100x_1+125x_2 <=60000$

$x_1>=0, x_2>=0$

Since $x_1$ and $x_2$ are the number of packets to be made of type A and B biscuits, $x_1$ and $x_2$ should be integers.

**Solution:** For maximum revenue, the factory should produce the following number of packets of biscuits per day:

Type A biscuits: 508 packets

Type B biscuits: 73 packets

**Code : opt1.m**

2.) Optimizing the machinery management as the machines can only function for limited hours in one go.

Minimize $z = x_1 + x_2 + x_3 + x_4$

Machine A- For kneading dough
Machine B- For baking
Machine C- For refrigeration
Machine D- For packing

Machine A can work at most for 6 hours
Machine B can work at most for 4 hours
Machine C can work at most for 10 hours
Machine D can work at most for 4 hours

Due to electricity restrictions, only one machine can run at a time i.e. when one machine is working rest remain ideal.

Let $x_1$ denote time required for kneading the dough
Let $x_2$ denote time required for baking.
Let $x_3$ denote time required for refrigeration.
Let $x_4$ denote time required for packing.

**Constraints:**

$X_1 <= 6$
$X_2 <= 4$
$X_3 <= 10$

$X_4 <= 4$

$X_1+X_2 >= 3$

$X_3+ X_4 >= 8$

$x_1, x_2, x_3, x_4 >= 1$

**Solution:** The machines should work for the following hours per day:

Machine A: 1 hour

Machine B: 2 hours

Machine C: 4 hours

Machine D: 4 hours

**Code: opt2.m**

**3.)** Optimizing the manpower to operate the particular machine and producing the particular output according to their working hours and slots .

Minimize : $Z=x_1 + x_2 + x_3 + x_4 + x_5$

Let $x_1$ workers starting their shift in time slot 8 am to 12 pm

Let $x_2$ workers starting their shift in time slot 12 pm to 4 pm.

Let $x_3$ workers starting their shift in time slot 4 pm to 8 pm.

Let $x_4$ workers starting their shift in time slot 8 pm to 12 am.

Let $x_5$ workers starting their shift in time slot 12am to 4 am.

Let $x_6$ workers starting their shift in time slot 4 am to 8 am.

The daily requirement of workers in the factory for respective slots is given below:

| | |
|---|---|
| 8:00 to 12noon | 12 workers |
| 12noon to 4 pm | 15 workers |
| 4pm to 8pm | 10 workers |

| | |
|---|---|
| 8pm to 12midnight | 8 workers |
| 12midnight to 4am | 6 workers |
| 4am to 8am | 10 workers |

**CONSTRAINTS :**

$x_1 + x_2 >= 15$

$x_2 + x_3 >= 10$

$x_3 + x_4 >= 8$

$x_4 + x_5 >= 6$

$x_5 + x_6 >= 10$

$x_6 + x_1 >= 12$

$x_1, x_2, x_3, x_4, x_5, x_6 >= 0$

**SOLUTIONS:** For the corresponding Optimization function the results are as follows

$x_1 = 12$ $x_2 = 3$ $x_3 = 8$ $x_4 = 0$ $x_5 = 10$ $x_6 = 0$

**Code: opt3.m**

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