FIT3158 Note - W1 Explore the use of linear programming (LP) in solving optimisation problems

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▼ TOC

▼ TOC by section

Discuss the characteristics of optimisation problems

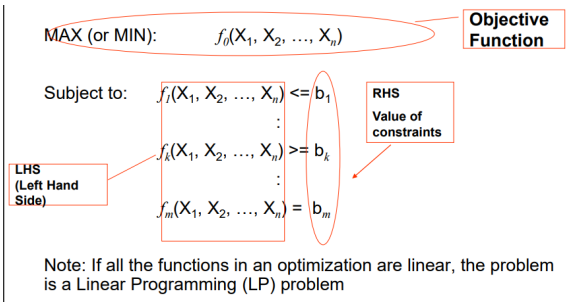
What is optimisation?

Finds the optimal, or most efficient, way of using limited resources to achieve the objectives of an individual of a business.

What is the application of optimisation?

- **Determining Product Mix**
  - How many of each product to produce to **maximise profits** or to satisfy demand at **minimum cost**?
- **Manufacturing**
  - Eg. For a circuit board, what is the drilling order that **minimises total distance** the drill bit must be moved?
- **Routing and Logistics**
  - What is the **least costly** method of transferring goods from warehouses to stores?
- **Financial Planning**
  - How much to save in superannuation to **minimise tax liability**?

General Form of an Optimization Problem



Note: If all the functions in an optimization are linear, the problem is a Linear Programming (LP) problem

Explore the use of linear programming (LP) in solving optimisation problems

Blue Ridge Hot Tubs produces two types of hot tubs: Aqua-Spas & Hydro-Luxes.

	Aqua-Spa	Hydro-Lux
Pumps	1	1
Labor	9 hours	6 hours
Tubing	12 feet	16 feet
Unit Profit	$350	$300

There are 200 pumps, 1566 hours of labor, and 2880 feet of tubing available.

1. Understand the problem.
2. Define the decision variables.

   `X_1 =number of Aqua-Spas to produce`

   `X_2 =number of Hydro-Luxes to produce`
3. Define the objective function

   `MAX: 350X 1 + 300X 2`
4. Define the constraints
   a. For this step, there are types of constraints in other cases, namely Demand Constraints, Resource Constraints, and Non-negativity conditions (which the next step).

$$1X_1 + 1X_2 <= 200 \quad \text{} \text{ pumps}$$
$$9X_1 + 6X_2 <= 1566 \quad \text{} \text{ labor}$$
$$12X_1 + 16X_2 <= 2880 \quad \text{} \text{ tubing}$$

5. Identify any upper or lower bounds on the decision variables.

   `X1 >= 0 && X2 >= 0`

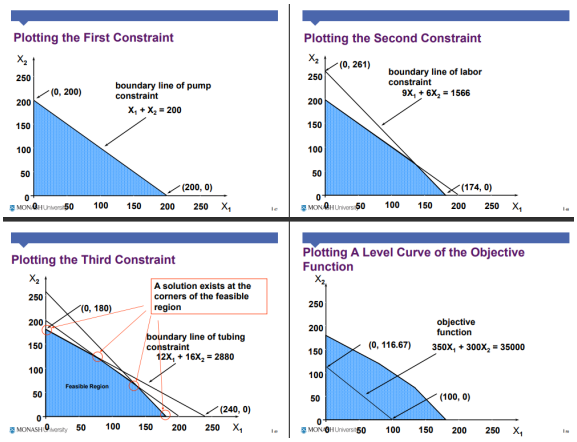
$$\text{MAX: } 350X_1 + 300X_2$$
$$\text{S.T.: } 1X_1 + 1X_2 <= 200$$
$$9X_1 + 6X_2 <= 1566$$
$$12X_1 + 16X_2 <= 2880$$
$$X_1 >= 0$$
$$X_2 >= 0$$

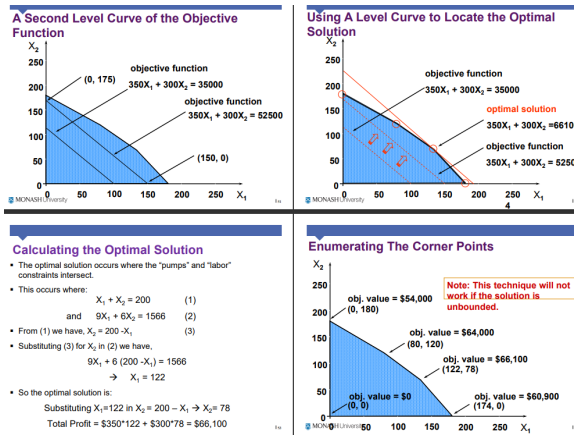
Solving LP problems using graphical approach

- The constraints of an LP problem defines its feasible region.
- The best point in the feasible region is the optimal solution to the problem.
- For LP problems with 2 variables, it is easy to plot the feasible region and find the optimal solution.

1. Plot the boundary line of each constraint
2. Identify the feasible region
3. Locate the optimal solution by either:
   a. Plotting level curves
   b. Enumerating the extreme points

In Summary

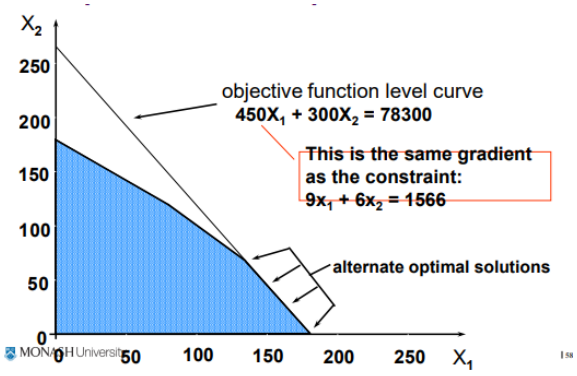


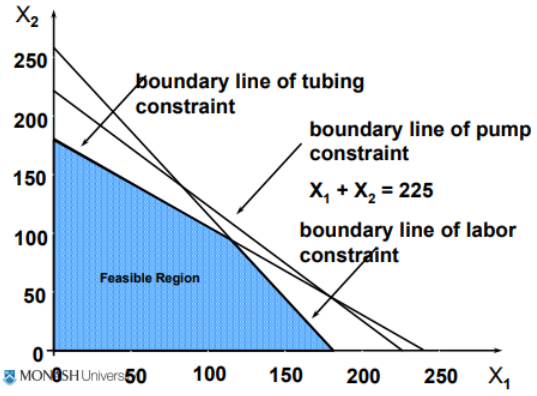


Special condition

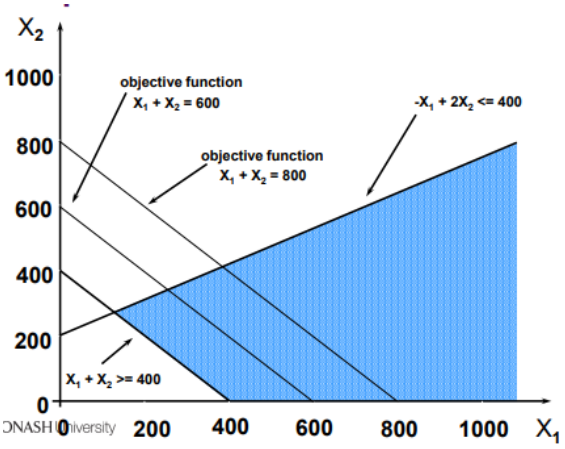
Case 1: Alternate Optimal Solutions

Case 2: Redundant Constraint





Case 3: Unbounded Solution



Case 4: Infeasibility