

# Beautiful Linear Programming

Muhammad Yasirroni

March 30, 2023

## 1 Linear Programming

$$\text{minimize } q^T x \quad (1)$$

$$Ax \preceq b \quad (2)$$

To find decision variables that maximize or minimize a linear objective function, subject to a set of linear constraints.

The  $x$  is the vector of decision variables,  $q$  and  $b$  are vectors of coefficients, and  $A$  is a matrix of coefficients with number of rows and columns equal to the number of linear constraints and decision variable, respectively.

## 2 Quadratic Programming

$$\text{minimize } \frac{1}{2} x^T Q x + q^T x \quad (3)$$

$$Ax \preceq b \quad (4)$$

To find decision variables that maximize or minimize a quadratic objective function, subject to a set of linear constraints.

The  $x$  is the vector of decision variable,  $q$  and  $b$  are vectors of coefficients,  $A$  is a matrix of coefficients with number of rows and columns equal to the number of linear constraints and decision variable, respectively, and  $Q$  is a diagonal matrix of coefficients with number of rows and columns equal to the number of decision variable.

### 3 Linear Constraints

Each **constraint** in **linear constraints** must be expressed in linear expressions terms. It means that each **constraint** must be expressed as a summation of **constants** that is multiplied with **decision variables** raised to the power of 1. The **constants** itself can be 0 if a **decision variable** is not used in that **constraint**. The use of  $\preceq$  in **constraints** means that each row of  $Ax$  must be less than  $b$ .

### 4 Types of Decision Variables

**Decision variable** can be strictly integer or continues. If an optimization problem consist of both types of **decision variables**, it is called **mixed-integer** programming. If a **mixed-integer** programming problem has **linear objective function** it is called **mixed-integer linear** programming. If a **mixed-integer** programming problem has **quadratic objective function**, it is called **mixed-integer quadratic** programming.