Mathematical Model for Alloy Production

Objective

Minimize the total cost of the alloys used in the production:

$$\text{Minimize} \quad \sum_{k=1}^{K} \text{Price}_k \cdot x_k$$

Constraints

1. The total quantity of alloys produced is exactly AlloyQuantity:

$$\sum_{k=1}^{K} x_k = \text{AlloyQuantity}$$

2. The quantity of each target component in the alloy must be met or exceeded:

$$\sum_{k=1}^{K} \text{Ratio}_{k,m} \cdot x_k \geq \text{Target}_m \quad \forall m \in \{1, 2, \ldots, M\}$$

3. The quantity of component k in alloy m must adhere to the specified Ratio:

$$\text{Ratio}_{k,m} \cdot x_k \quad \text{(implicitly included in the above constraint)}$$

4. Each alloy's quantity is non-negative:

$$x_k \geq 0 \quad \forall k \in \{1, 2, \ldots, K\}$$

Parameters

- AlloyQuantity: Total quantity of alloy to produce (constant)
- Target_m: Quantity of target components in the alloy for each $m \in \{1, 2, \ldots, M\}$
- $\text{Ratio}_{k,m}$: Ratio of each component k in the alloy m for each $k \in \{1, 2, \ldots, K\}$ and $m \in \{1, 2, \ldots, M\}$
- Price_k: Price of each alloy k for each $k \in \{1, 2, \ldots, K\}$

Decision Variables

$$x_k \quad \text{(quantity of alloy } k \text{ to produce)}$$