BA885 Group 10 - Project Proposal

Project Draft: Hospital Meal Ordering Optimization

1. Problem Statement

In this project, we aim to develop an optimization model for **diet planning for hospital patients**. The primary objective is to minimize the total cost of food, for weekly/monthly orders, while ensuring that patients' nutritional needs are met according to dietary guidelines prescribed for their medical conditions. Hospital dietary planning involves several challenges, including managing costs, ensuring nutritional balance, and meeting specific dietary requirements for different patients for example diabetics, cardiac patients etc.
This problem is worth undertaking because optimizing hospital food procurement and planning can significantly reduce operational costs while maintaining or improving patient care. As healthcare costs rise, hospitals need to balance quality nutrition with financial constraints. The goal of this project is to help hospitals better manage resources, improve patient satisfaction, and ensure better health outcomes.

2. Optimization Model Formulation

Objective function: Minimize the total cost of meals ordered, defined as:

$$\text{Minimize } Z = \sum_{i=1}^{n} c_i \cdot q_i$$

where:

- c_i = cost per unit of meal type *i*
- q_i = quantity of meal item *i* to order

Decision Variables:

- q_i = quantity of meal type *i* (e.g., diabetic, cardiac, general health) to order.

Constraints:

1. **Patient Dietary Requirements**: Each meal type must satisfy the nutritional requirements for a given patient group (e.g., diabetic, cardiac patients) based on the weekly patient count:

$$\sum_{i=1}^{n} a_{ij} \cdot q_i \geq b_j \cdot P_j$$

   where:
   - a_{ij} is the amount of nutrient *j* in food item *i*
   - q_i is the required nutrient intake for patient type *j*
   - P_j is the number of patients of type *j*
2. **Caloric and Nutritional Requirements**: The total nutritional value of the meals must meet the prescribed daily allowances (RDAs) for each patient group (e.g., diabetic patients require low sugar meals):

$$\sum_{i=1}^{n} cal_i \cdot q_i \geq required\ calories\ for\ patient\ group_j \cdot P_j$$

3. **Meal Variety**: To ensure variety in patients' meals, a constraint could be added to include a minimum number of different meal types:

$$\sum_{i=1}^{n} q_i \geq minimum\ order\ quantity_i \quad \forall i$$

4. **Supply Constraints**: Each meal type has limited supply, so the total quantity ordered cannot exceed the supplier's maximum availability:

$$\sum_{i=1}^{n} q_i \leq supplier\ capacity_i \quad \forall i$$

3. Data Collection

To obtain the necessary data, we will research hospitals or companies that specialize in providing food for medical facilities. From the hospital data we will retrieve the average number of patients of a given gender and age range with condition 'x' seen as inpatient hospitals during a week or month. This will allow us to estimate our meal/nutritional requirements for the week/month. From hospital catering companies we will get data on meal nutritional information and cost per meal. An example of a company we might call to retrieve hospital catering information is **Delegate Healthcare Solutions LLC** (Data Link). We will combine a source like this to another dataset consisting of patient information from a hospital.

4. Anticipated Results

We expect that the optimization model will provide a cost-efficient diet plan for each patient group that satisfies all nutritional requirements in the hospital. The model will select the most affordable options that fulfill the required nutritional criteria and ensure nutritional adequacy such as minimum and maximum caloric intake, protein, fats, vitamins, and other nutrients based on patient health conditions (e.g., patients with diabetes, cardiovascular conditions, etc.). Additionally, we expect the model to contribute to a reduction in the hospital's overall food budget while maintaining high standards of nutritional care for all patients.

5. Potential Implications

Implementing this optimization model could lead to significant cost savings for hospitals, especially those serving large and diverse patient populations. By optimizing meal orders, hospitals can ensure that patient care remains high-quality while reducing unnecessary expenditures. Furthermore, it could be integrated into the hospital's existing food ordering systems to streamline procurement and inventory management. This project can be scaled to other healthcare institutions, such as nursing homes or rehabilitation centers, which face similar challenges in meal planning.