Compulsory Assignment 1

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1 Problem Description

We are considering how we arrange our food for nutrition balance. There are some basic constraints,

1. The total **energy** should be at least 10000kJ;
2. The energy come from **fat** should be between 20% and 30% of the total energy;
3. The energy come from **carbohydrates** should be between 55% and 60% of the total energy;
4. Assume we get the remained energy from **protein**.
5. 1g fat(resp. carbohydrates and protein) contain 38kJ(17kJ and 17kJ resp. carbohydrates and protain);

Now we should decide what we eat in one day and find out the energy disribution. I pick up the following food and list their energy and price,

Food	Fat	Carbohydrates	Protein	Price
Skimmed Milk	0.3%	4.7%	3.5%	8Dkk/kg
Raw Salmon	10.9%	0%	19.9%	146Dkk/kg
Raw Cucumber	0.1%	2.1%	0.7%	40Dkk/kg
Savoy Cabbage	0.1%	6.1%	2.0%	30Dkk/kg
Rice	1.2%	79%	1.2%	10Dkk/kg

2 Solution

Let $\mathcal{I}$ be the food set and $\mathcal{J}$ be the nutrition set. Let a_{ij} := the percentage that food i contain nutrition j with, p_i := the price(Dkk/kg) of food i, e_j := the energy(kJ/g = 1000kJ/kg = kkJ/kg) of nutrition j, for $i \in \mathcal{I}, j \in \mathcal{J}$.

To come up with the **Linear Problem**, we let w_i be the variables standing for the consumption(kg) of food i. We want to minimize the total cost(DKK) in one day $\sum_{i\in\mathcal{I}} p_i w_i$.

We let $s_{ij} := w_i a_{ij} e_j$ denote the energy(kkJ) obtained in nutrition j from food i, for $i \in \mathcal{I}, j \in \mathcal{J}$. We let $E := \sum_{i\in\mathcal{I},j\in\mathcal{J}} s_{ij}$ denote the total energy(kkJ) one may have in one day. Similarly, we let $E_f := \sum_{i\in\mathcal{I}} s_{i,1}$ and $E_c := \sum_{i\in\mathcal{I}} s_{i,2}$ denote the fat energy(kkJ) and carbohydrates energy(kkJ) respectively one may have in one day.

Now we can translate the total energe constraint as $E \geq 10$ where 10kkJ equals to 10000kJ, the fat energy constraint as $E_f \geq 0.2E$ and $E_f \leq 0.3E$, the carbohydrates energy constraint as $E_c \geq 0.55E$ and $E_c \leq 0.6E$. Also, we need to constraint all the variables nonnegative.