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.

We get approximate optimal total price at 71.53DKK by consuming about 862.9g Milk, 415.6g Salmon and 395.4g Rice. But at this solution, we do not have to eat any vegetable.

We can assume w_3 and w_4 at least 0.1 both which indicates we must eat some vegetable.

Now we get the approximate optimal total price at 77.98DKK by consuming about 782.0g Milk, 416.6g Salmon, 100.0g Cucumber, 100.0g Cabbage, 390.0g Rice.