

Diet Problem – Shipping fee

Math Model & Decision Analysis Assignment 1

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Introduction

I am personally interested in LCHF (Low-Carbohydrates High-Fat) diet. I think solving this problem which fitted to my personal condition, would benefit to my health and economic position. There are several requirements for this diet:

- Ideal ratio of having Carbohydrates: Protein: Fat is 1:2:7
- Carbohydrates consumption must not exceed 50g per day. (Moderate level)
- Lower Carbohydrates is good.
- Total amount of calories should be over 3000 calories.
- There is no cap in how much eating, but shouldn't exceed 5000 calories per day.

We previously have solved the LCHF diet cost-efficient product and found that Pork belly was the most cost-effective product for fulfilling fat. We would like to introduce new variables.

I would like to schedule a diet plan to buy ingredients more efficiently from various markets. All ingredients other than meat are shared with family and I will be only supplying all meats consumed at home via online shopping. Family of four people will need at least 1.2 kg to have sufficient amount of meat.

- At least some of three different meat is needed. Whole chicken is considered as 500g
- We will order meat from either Woolworth or Coles.

Packages of meats are:

Food	Size	Price(AUD)	Woolworths	Coles
Pork Belly	250g		5.00	16.25
Roasted Chicken	whole		6.00	6.00
Beef	300g		4.50	2.1

And I am trying to order ingredients from online stores using deliever

Company	Shipping fee	Limit
Woolworths	\$5	Under 1 kg
Coles	\$6	Under 1 kg

We will be considering two cases:

- when the limit per shipping exists
- when the limit does not exist

Method

Our aim for this integer programming is to minimize cost for ordering meat. Let:

x11	Number of pork belly packages ordered from Woolworths
x12	Number of pork belly packages ordered from Coles
x21	Number of whole chicken ordered from Woolworths
x22	Number of whole chicken ordered from Coles
x31	Number of beef packages ordered from Woolworths
x32	Number of beef packages ordered from Coles
y1	Shipping fee from Woolworths
y2	Shipping fee from Coles

Our objective function is:

(Objective function) Minimize $z = 5x_{11} + 16.25x_{12} + 6x_{21} + 6x_{22} + 4.5x_{31} + 2.1x_{32} + y_1 + y_2$

Where z is total cost. We have constraints:

(Total Amount)	$2.5 * (x_{11} + x_{12}) + 5 * (x_{21} + x_{22}) + 3 * (x_{31} + x_{32}) \geq 12$
(Pork Belly)	$x_{11} + x_{12} \geq 1$
(Chicken)	$x_{21} + x_{22} \geq 1$
(Beef)	$x_{31} + x_{32} \geq 1$
(Binary)	$y_1, y_2 = 0 \text{ or } 1$
(Non-Negativity)	$x_{11}, x_{12}, x_{21}, x_{22}, x_{31}, x_{32} \geq 0 \text{ and integers}$

When the shipping limit does exist

(Woolworths)	$2.5 * x_{11} + 5 * x_{21} + 3 * x_{31} \leq 10 * y_1$
(Coles)	$2.5 * x_{12} + 5 * x_{22} + 3 * x_{32} \leq 10 * y_2$
(Non-Negativity)	$x_{11}, x_{12}, x_{21}, x_{22}, x_{31}, x_{32}, y_1, y_2 \geq 0 \text{ and integers}$

Results

Shipping limit does not exist

Food	Packages	Measurement
X11	1	250g
X12	0	
X21	1	1 whole chicken
X22	0	0
X31	2	600g
X32	0	0
Y1	1	
Y2	0	

Total \$25 AUD

The order was only made from Woolworth when the limit per shipping does not exist.

The order was 1 pack of pork belly, 1 whole chicken and 2 packs of beef.

Shipping limit does exist

Food	Packages	Measurement
X11	1	250g
X12	0	
X21	1	1 whole chicken
X22	0	
X31	0	
X32	2	600g
Y1	1	
Y2	1	

Total \$26.2 AUD

When shipping limit does exist, the order was made separately. 1 pack of pork belly and 1 whole chicken was ordered from Woolworth and 2 packs of beef was ordered from Coles.

Binding constraints are buying 3 kinds of meats: buying at least a pack of pork belly and a whole chicken. Regarding this binding constraints, beef is the most cost efficient product per amount (weight in grams).

Shipping limit does exist & Not required to buy three different kinds of meats

Food	Packages	Measurement
X11	0	
X12	0	
X21	0	
X22	0	
X31	0	
X32	4	1200g
Y1	0	
Y2	2	
Total \$20.4 AUD		

The order was made twice from Coles, and beef only.

To conclude, beef from Coles is the most cost effective product. With the shipping limit, buying a whole chicken and a pack of pork belly from Woolworths and 2 packs of beef from Coles is the most effective way of supplying meats to family.

References

(USDA Food Composition Database, n.d.)

<https://ndb.nal.usda.gov>