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## 5. Pastry Purchase

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Problem Set A due Sep 15, 2021 20:30 IST



Practice

Pastry 1

1/1 point (graded)  
A pastry shop sells croissants, donuts, and brioches. You are in charge of purchasing pastries for your company. The pastry shop offers three package deals:

- 1. Box A comes with 6 croissants, 4 donuts, and 2 brioches.
- 2. Box B comes with 0 croissants, 12 donuts, and 0 brioches.
- 3. Box C comes with 6 croissant, 0 donuts, and 6 brioches.

Suppose you purchase  $x_1$  of box A,  $x_2$  of box B,  $x_3$  of box C. Let  $y_1, y_2, y_3$  be the total number of croissants, donuts, and brioches that result. There is a matrix  $M$  such that  $\begin{pmatrix} y_1 \\ y_2 \\ y_3 \end{pmatrix} = M \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$ . What is  $M$ ?

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$M =$   ✓ Answer: `[[6 , 0 , 6 ],[ 4 , 12 , 0 ],[ 2 , 0 , 6 ]]`

Solution:

We can set up the equations for the  $y$ 's:

$$y_1 = 6x_1 + 0x_2 + 6x_3 \tag{5.194}$$

$$y_2 = 4x_1 + 12x_2 + 0x_3 \tag{5.195}$$

$$y_3 = 2x_1 + 0x_2 + 6x_3 \tag{5.196}$$

For example, the first equation says that the total number of croissants is 6 times the number of box A's, plus 6 times the number of box C's.

Then we extract the matrix:

$$\begin{pmatrix} y_1 \\ y_2 \\ y_3 \end{pmatrix} = \begin{pmatrix} 6 & 0 & 6 \\ 4 & 12 & 0 \\ 2 & 0 & 6 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} \tag{5.197}$$

Therefore  $M = \begin{pmatrix} 6 & 0 & 6 \\ 4 & 12 & 0 \\ 2 & 0 & 6 \end{pmatrix}$ .

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You have used 1 of 3 attempts

Answers are displayed within the problem

Pastry 2

1/1 point (graded)  
A few company workers want to know the nutritional information of these orders you'

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1. Each croissant has 26g of carbohydrate, 5g of protein, and 12g of butter.
2. Each donut has 22g of carbohydrate, 2g of protein, and 11g of butter.
3. Each brioche has 39g of carbohydrate, 7g of protein, and 5g of butter.

Suppose that you purchase  $y_1$  croissants,  $y_2$  donuts, and  $y_3$  brioches. Now let  $z_1, z_2, z_3$  be the total grams of carbohydrate, protein, and butter contained in your purchase. There is a matrix  $N$  such that

$\begin{pmatrix} z_1 \\ z_2 \\ z_3 \end{pmatrix} = N \begin{pmatrix} y_1 \\ y_2 \\ y_3 \end{pmatrix}$ . What is  $N$ ?

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$N =$ 

`[[26,22,39],[5,2,7],[12,11,5]]`

✓

**Answer:** `[[26, 22, 39],[ 5, 2, 7],[ 12, 11, 5]]`

**Solution:**

We can set up the equations for the  $z$ 's:

$z_1 = 26y_1 + 22y_2 + 39y_3$

(5.198)

$z_2 = 5y_1 + 2y_2 + 7y_3$

(5.199)

$z_3 = 32y_1 + 12y_2 + 5y_3$

(5.200)

For example, the first equation says that the carbohydrate total is given by 26 times the number of croissants, plus 22 times the number of donuts, plus 39 times the number of brioches.

Then we extract the matrix:

$\begin{pmatrix} z_1 \\ z_2 \\ z_3 \end{pmatrix} = \begin{pmatrix} 26 & 22 & 39 \\ 5 & 2 & 7 \\ 12 & 11 & 5 \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \\ y_3 \end{pmatrix}$

(5.201)

Therefore  $N = \begin{pmatrix} 26 & 22 & 39 \\ 5 & 2 & 7 \\ 12 & 11 & 5 \end{pmatrix}$ .

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You have used 1 of 3 attempts

**i** Answers are displayed within the problem

Pastry 3

1/1 point (graded)

Suppose again that you purchase  $x_1$  of box A,  $x_2$  of box B,  $x_3$  of box C. And let  $z_1, z_2, z_3$  be the total grams of carbohydrate, protein, and butter contained in your purchase. There is a matrix  $P$  such that

$\begin{pmatrix} z_1 \\ z_2 \\ z_3 \end{pmatrix} = P \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$ . What is  $P$ ?

In this answer box, you may type 'M' and 'N' for the matrices  $M$  and  $N$  computed above (or you may enter a matrix numerically). You can enter a matrix product such as  $AB$  using "A\*B".

$P =$ 

`[[322,264,390], [52,24,72], [1`

✓

**Answer:** `N*M`

**Solution:**

We have shown that  $\vec{z} = N\vec{y}$  and  $\vec{y} = M\vec{x}$ . It follows that  $\vec{z} = NM\vec{x}$ , so the answer is the matrix  $NM$ . Numerically, this is:

$$\begin{pmatrix} 322 & 264 & 390 \\ 52 & 24 & 72 \\ 126 & 132 & 102 \end{pmatrix}$$

(5.202)

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You have used 1 of 3 attempts

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Pastry 4

1/1 point (graded)  
The office workers have decided that they want exactly 688g of carbohydrate, 546g of protein, and 892g of butter in the next order. As before, let  $x_1$ ,  $x_2$ , and  $x_3$  be the number of box A,B,C that you order respectively. Which of the following equations gives the correct values of  $x_1, x_2, x_3$  to satisfy the office workers?

- ☐  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = NM^{-1} \begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$
- ☐  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = N^{-1} \begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$
- ☐  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = N^{-1}M^{-1} \begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$
- ☒  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = M^{-1}N^{-1} \begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$
- ☐  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = M^{-1} \begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$



Solution:

Here we are given the desired  $z$ 's, namely  $\vec{z} = \begin{pmatrix} z_1 \\ z_2 \\ z_3 \end{pmatrix}$  should equal  $\begin{pmatrix} 688 \\ 546 \\ 892 \end{pmatrix}$ , and asked to find the  $x$ 's. Let  $\vec{x} = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$  be the unknown number of boxes to order. We know from the previous problem that

$$\vec{z} = NM\vec{x}$$

(5.203)

Multiplying by  $N^{-1}$  on both sides, we obtain:

$$N^{-1}\vec{z} = M\vec{x},$$

(5.204)

and doing the same with  $M^{-1}$ , we have

$$M^{-1}N^{-1}\vec{z} = \vec{x}.$$

(5.205)

Therefore, given the  $z$ 's, we obtain the  $x$ 's by multiplying by  $M^{-1}N^{-1}$ .

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**i** Answers are displayed within the problem


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