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FREE LEARNING NOTES FOR ZAMBIA

FORM 1

Mathematics

Matrices: adding, subtracting and multiplying in real life

Lesson notes for learners · Competence-Based Curriculum

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A matrix is a way of arranging numbers in rows and columns so that we can handle a lot of information at once. Accounting officers use matrices to track budgets, a shop owner in Kitwe can use them to keep stock records, and a band planning a tour can use them to work out costs. In this note you learn the operations on matrices and use them on real situations.

AFTER THESE NOTES YOU SHOULD BE ABLE TO

- Write information from a real situation in matrix form
- Add and subtract matrices of the same order
- Multiply a matrix by a constant (scalar)
- Multiply a matrix by a matrix, up to 2 by 2, and say when it is possible
- Explain that matrix multiplication is not commutative

KEY WORDS

matrix	numbers arranged in rows and columns inside brackets
order of a matrix	the number of rows by the number of columns, for example 3 by 2
element	one number in a matrix
scalar	an ordinary number used to multiply every element of a matrix
commutative	giving the same answer whichever way round you do the operation

1 Writing information as a matrix

Rows go across and columns go down. A matrix with 3 rows and 3 columns has order 3 by 3. To form a matrix from a situation, keep the same position for the same kind of information. In the table below, each row is a district and each column is a department. The matrix is just the nine numbers, kept in the same positions.

The table gives the weekly budget (in thousands of kwacha) for three districts. We call it Matrix A. Week 2 is Matrix B, and its numbers are given in the examples.

	Education	Health	Transport
District 1	120	90	75
District 2	100	85	60
District 3	110	95	70

Figure 1. Matrix A: Week 1 budget in thousands of kwacha

2 Adding and subtracting matrices

To add or subtract two matrices, they must be of the same order. Then add or subtract the elements that are in the same positions.

WORKED EXAMPLE

Week 1 budget A is [120 90 75; 100 85 60; 110 95 70]. Week 2 budget B is [130 85 80; 95 88 65; 115 92 75]. Find C, the total over the two weeks, and the change from Week 1 to Week 2.

Both are 3 by 3, so we can add them

Row 1 of A + B: 120+130 = 250, 90+85 = 175, 75+80 = 155

Row 2: 100+95 = 195, 85+88 = 173, 60+65 = 125

Row 3: 110+115 = 225, 95+92 = 187, 70+75 = 145, so C = [250 175 155; 195 173 125; 225 187 145]

Change B − A: row 1 is 10, −5, 5; row 2 is −5, 3, 5; row 3 is 5, −3, 5

Funding fell for Health in District 1, Education in District 2 and Health in District 3

3 Multiplying a matrix by a scalar

To multiply a matrix by a number, multiply every element by that number. Suppose one concert costs K1,200 for the venue, K800 for equipment, K500 for staff and security and K300 for transport, written as a column. For 5 concerts we multiply each entry by 5.

WORKED EXAMPLE

The costs for one concert are [1200; 800; 500; 300]. Find the costs for 5 concerts.

Multiply every element by 5

1200 × 5 = 6000 and 800 × 5 = 4000

500 × 5 = 2500 and 300 × 5 = 1500

The costs are [6000; 4000; 2500; 1500]

4 Multiplying a matrix by a matrix

Two matrices can be multiplied only when the number of columns in the first equals the number of rows in the second. To get an element of the answer, multiply the elements of a row of the first matrix by the matching elements of a column of the second, and add the products.

Matrix multiplication is not commutative: if A and B can be multiplied both ways, A × B and B × A usually give different answers.

WORKED EXAMPLE

A shop has stock X = [30 50; 40 35] (rows Kitwe, Lusaka; columns calculators, mathematical sets). The prices are Y = [70 65 60; 50 45 40] (rows calculators, sets; columns standard, discounted, wholesale price in kwacha). Find the value of stock in each branch at each price.

X has 2 columns and Y has 2 rows, so X × Y can be found

Kitwe, standard: 30×70 + 50×50 = 2100 + 2500 = 4600

Kitwe, discounted: 30×65 + 50×45 = 1950 + 2250 = 4200

Kitwe, wholesale: 30×60 + 50×40 = 1800 + 2000 = 3800

Lusaka: 40×70 + 35×50 = 4550, then 40×65 + 35×45 = 4175, then 40×60 + 35×40 = 3800

So X × Y = [4600 4200 3800; 4550 4175 3800]

TRY THIS

In pairs, use your class results or the prices of three items in a local shop. Write the quantities sold on two days as two matrices of the same order, add them to get the total, subtract them to find the change, and multiply one of them by 3 to show what happens if sales triple.

REMEMBER

- A matrix is numbers arranged in rows and columns; its order is rows by columns
- Add or subtract matrices of the same order, element by element
- To multiply by a scalar, multiply every element
- To multiply two matrices, columns of the first must equal rows of the second
- Matrix multiplication is not commutative

? Check yourself

1. State the order of a matrix with 2 rows and 3 columns.
2. When can two matrices be added?
3. Find 4 × [2 5; 1 3].
4. Find [1 2; 3 4] + [5 0; 2 1].
5. Given A = [1 2; 3 4] and B = [0 1; 1 0], find A × B and B × A. What do the answers show?
6. A shop (kantemba) receives deliveries of milk, bread and vegetables in crates from two suppliers. Week 1 is W = [10 8 6; 12 9 5] and Week 2 is K = [11 7 8; 10 12 6], with rows for Supplier A and B. (a) Find W + K. (b) Find K − W. (c) Which supplier and item had a reduction from Week 1 to Week 2?
7. A school tuck shop records its stock as Q = [12 8; 20 10], with rows Monday and Tuesday and columns buns and sodas. A new delivery doubles every number. (a) Write the matrix for the delivery. (b) Find the stock after adding the delivery to Q. (c) Explain how you got (b) in terms of a scalar.

ANSWERS

1. 2 by 3.
2. When they are of the same order.
3. [8 20; 4 12].
4. [6 2; 5 5].
5. A × B = [2 1; 4 3] and B × A = [3 4; 1 2]. They are different, so matrix multiplication is not commutative.
6. (a) W + K = [21 15 14; 22 21 11]. (b) K − W = [1 −1 2; −2 3 1]. (c) Supplier A bread (down by 1) and Supplier B milk (down by 2).
7. (a) 2Q = [24 16; 40 20]. (b) Q + 2Q = [36 24; 60 30]. (c) Adding Q and 2Q is the same as multiplying Q by the scalar 3.

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