

## Lesson 4-2

### Example 1 Add Matrices

a. Find  $C + D$  if  $C = \begin{bmatrix} 1 & 0 & -3 \\ -5 & 6 & 0 \end{bmatrix}$  and  $D = \begin{bmatrix} 0 & -3 \\ 2 & 2 \\ -5 & 6 \end{bmatrix}$ .

Since the dimensions of  $C$  are  $2 \times 3$  and the dimensions of  $D$  are  $3 \times 2$ , you cannot add these matrices.

b. Find  $A + C$  if  $A = \begin{bmatrix} -4 \\ 0 \\ 5 \\ 2 \end{bmatrix}$  and  $C = \begin{bmatrix} 1 \\ -6 \\ 0 \\ -2 \end{bmatrix}$ .

$$A + C = \begin{bmatrix} -4 \\ 0 \\ 5 \\ 2 \end{bmatrix} + \begin{bmatrix} 1 \\ -6 \\ 0 \\ -2 \end{bmatrix} \quad \text{Definition of matrix addition}$$

$$= \begin{bmatrix} -4+1 \\ 0+(-6) \\ 5+0 \\ 2+(-2) \end{bmatrix} \quad \text{Add corresponding elements.}$$

$$= \begin{bmatrix} -3 \\ -6 \\ 5 \\ 0 \end{bmatrix} \quad \text{Simplify.}$$

### Example 2 Subtract Matrices

Find  $D - C$  if  $C = \begin{bmatrix} 7 & -1 & 4 \\ -3 & 0 & 2 \end{bmatrix}$  and  $D = \begin{bmatrix} 4 & -8 & 0 \\ -2 & -3 & 2 \end{bmatrix}$ .

$$D - C = \begin{bmatrix} 4 & -8 & 0 \\ -2 & -3 & 2 \end{bmatrix} - \begin{bmatrix} 7 & -1 & 4 \\ -3 & 0 & 2 \end{bmatrix} \quad \text{Definition of matrix subtraction}$$

$$= \begin{bmatrix} 4-7 & -8-(-1) & 0-4 \\ -2-(-3) & -3-0 & 2-2 \end{bmatrix} \quad \text{Subtract corresponding elements.}$$

$$= \begin{bmatrix} -3 & -7 & -4 \\ 1 & -3 & 0 \end{bmatrix} \quad \text{Simplify.}$$

### Example 3 Use Matrices to Model Real World Data

**OLYMPICS** The table below shows the total number of gold, silver, and bronze medals won by three countries in the Olympics from 1924–1998.

Country	Gold	Silver	Bronze
Norway	83	87	69
Soviet Union (1956-1988)	78	57	59
United States	59	59	41

Source: 2001 ESPN Sports Almanac

#### a. How many more gold than bronze medals did each country win?

The data about the gold and bronze medals can be organized in two matrices. Then you can find the difference between the two matrices to answer the question.

Gold    Bronze

$$\begin{bmatrix} 83 \\ 78 \\ 59 \end{bmatrix} - \begin{bmatrix} 69 \\ 59 \\ 41 \end{bmatrix} = \begin{bmatrix} 83 - 69 \\ 78 - 59 \\ 59 - 41 \end{bmatrix} \quad \text{Subtract corresponding elements.}$$
$$= \begin{bmatrix} 14 \\ 19 \\ 18 \end{bmatrix} \quad \begin{array}{l} \text{Norway} \\ \text{Soviet Union} \\ \text{United States} \end{array}$$

#### b. How many medals did each country win?

The data about all medals can be organized into three matrices. Then you can add the matrices to find the total number of medals won by each country.

Gold    Silver    Bronze

$$\begin{bmatrix} 83 \\ 78 \\ 59 \end{bmatrix} + \begin{bmatrix} 87 \\ 57 \\ 59 \end{bmatrix} + \begin{bmatrix} 69 \\ 59 \\ 41 \end{bmatrix} = \begin{bmatrix} 83 + 87 + 69 \\ 78 + 57 + 59 \\ 59 + 59 + 41 \end{bmatrix} \quad \text{Add corresponding elements.}$$
$$= \begin{bmatrix} 239 \\ 194 \\ 159 \end{bmatrix} \quad \begin{array}{l} \text{Norway} \\ \text{Soviet Union} \\ \text{United States} \end{array}$$

#### Example 4 Multiply a Matrix by a Scalar

$$\text{If } B = \begin{bmatrix} 2 & -1 & 0 & 4 \\ 5 & 3 & -1 & -2 \\ 0 & 7 & 1 & -3 \end{bmatrix}, \text{ find } -2B.$$

$$-2B = -2 \begin{bmatrix} 2 & -1 & 0 & 4 \\ 5 & 3 & -1 & -2 \\ 0 & 7 & 1 & -3 \end{bmatrix}$$

$$= \begin{bmatrix} -2(2) & -2(-1) & -2(0) & -2(4) \\ -2(5) & -2(3) & -2(-1) & -2(-2) \\ -2(0) & -2(7) & -2(1) & -2(-3) \end{bmatrix} \quad \text{Multiply each element by } -2.$$

$$= \begin{bmatrix} -4 & 2 & 0 & -8 \\ -10 & -6 & 2 & 4 \\ 0 & -14 & -2 & 6 \end{bmatrix} \quad \text{Simplify.}$$

#### Example 5 Combination of Matrix Operations

$$\text{If } B = \begin{bmatrix} 1 & 0 & -3 \\ -2 & 5 & -1 \end{bmatrix} \text{ and } C = \begin{bmatrix} -6 & 2 & -1 \\ 0 & 5 & 3 \end{bmatrix}, \text{ find } 2C - 3B.$$

Perform the scalar multiplication first. Then subtract the matrices.

$$2C - 3B = 2 \begin{bmatrix} -6 & 2 & -1 \\ 0 & 5 & 3 \end{bmatrix} - 3 \begin{bmatrix} 1 & 0 & -3 \\ -2 & 5 & -1 \end{bmatrix} \quad \text{Substitution}$$

$$= \begin{bmatrix} 2(-6) & 2(2) & 2(-1) \\ 2(0) & 2(5) & 2(3) \end{bmatrix} - \begin{bmatrix} 3(1) & 3(0) & 3(-3) \\ 3(-2) & 3(5) & 3(-1) \end{bmatrix} \quad \text{Multiply each element in the first matrix by 2 and multiply each element in the second matrix by 3.}$$

$$= \begin{bmatrix} -12 & 4 & -2 \\ 0 & 10 & 6 \end{bmatrix} - \begin{bmatrix} 3 & 0 & -9 \\ -6 & 15 & -3 \end{bmatrix} \quad \text{Simplify.}$$

$$= \begin{bmatrix} -12-3 & 4-0 & -2-(-9) \\ 0-(-6) & 10-15 & 6-(-3) \end{bmatrix} \quad \text{Subtract corresponding elements.}$$

$$= \begin{bmatrix} -15 & 4 & 7 \\ 6 & -5 & 9 \end{bmatrix} \quad \text{Simplify.}$$