Application of Matrix Multiplication
ID: 13734

Activity Overview
In this activity, students will use matrix multiplication to determine the best price to charge for a beach rental property

Topic: Matrix Multiplication

- *Students will use matrices to represent data in an application.*
- *Students will multiply two matrices together.*
- *Students will interpret matrix numbers in the context of the application.*
- *Students will use matrix multiplication to answer questions regarding the application.*

Teacher Preparation and Notes

- *This activity is designed to be used in an Algebra 2 classroom.*
- *This activity has an extension in which students determine the amount of sales tax to charge using scalar multiplication.*
- *Notes for using the TI-Nspire™ Navigator™ System are included throughout the activity. The use of the Navigator System is not necessary for completion of this activity.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to education.ti.com/exchange and enter "13734" in the keyword search box.***

Associated Materials

- *Application_of_Matrix_Multiplication_Student.doc*
- *Application_of_Matrix_Multiplication.tns*

Suggested Related Activities
To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

- *Matrix Multiplication (TI-Nspire Technology) — 16030*
- *Calculations at the Crazy Cookie Factory (TI-Nspire Technology) — 9169*
- *Coded Messages (TI-Nspire Technology) — 16032*
- *Matrix Multiplication (TI-84 Plus family) — 2128*

Introduce the problem on page 1.2 along with the data on page 1.3. Students may need a reminder that a 4 × 3 matrix has 4 rows and 3 columns. The rows in the matrix will represent the seasons, because there are 4 different seasons. The 3 different rate categories will represent the columns.

	Weeknight	Weekend	Weekly
Spring	$150	$175	$1,000
Summer			$1,300
Fall	$150	$175	$1,000
Winter	$100	$150	$700

TI-Nspire Navigator Opportunity: *Quick Poll* and *Live Presenter*

See Note 1 at the end of this lesson.

As students click the arrows on page 1.6 to check their answer for question 1, note that the matrix has been color coded to match the data from page 1.3.

$$A = \begin{bmatrix} 150 & 175 & 1{,}000 \\ 0 & 0 & 1{,}300 \\ 150 & 175 & 1{,}000 \\ 100 & 150 & 700 \end{bmatrix}$$

On page 1.7 The information shows the numbers of weeknights, weekend nights, and weeks the beach condo was rented in each season during the first year. Students will need to rearrange the data on page 1.8 to fit a 3 × 4 matrix. Students should also keep the column headings "Weeknight," "Weekend," and "Weekly" in the same order.
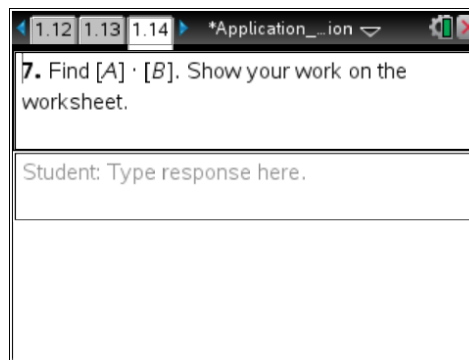
	Weeknight	Weekend	Weekly
Spring	15	14	3
Summer			8
Fall	12	10	4
Winter	9	6	2

TI-Nspire Navigator Opportunity: *Quick Poll* and *Live Presenter*

See Note 2 at the end of this lesson.

As students click the arrows on page 1.11 to check their answer for question 3, note that the matrix has been color coded to match the data from page 1.8.

2 = 3.

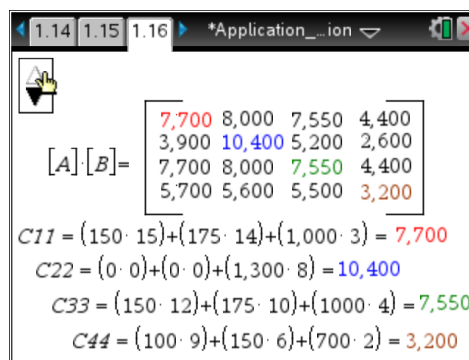$$B = \begin{bmatrix} 15 & 0 & 12 & 9 \\ 14 & 0 & 10 & 6 \\ 3 & 8 & 4 & 2 \end{bmatrix}$$

On page 1.14 students are to find [A][B] and show their work on their worksheet

> **1.12 1.13 1.14** ▶ *Application_...ion* ▽ 〔▯×
>
> **7.** Find [A] · [B]. Show your work on the worksheet.
>
> Student: Type response here.

TI-Nspire Navigator Opportunity: *Class Capture*

See Note 3 at the end of this lesson.

Have the students use the up/down arrows on page 1.16 to check their answer to Question 7.

As students answer question 9, note that the elements on the matrix's main diagonal has been color coded to aid the student.

> **1.14 1.15 1.16** ▶ *Application_...ion* ▽ 〔▯×
>
> $[A]\cdot[B]=\begin{bmatrix} 7{,}700 & 8{,}000 & 7{,}550 & 4{,}400 \\ 3{,}900 & 10{,}400 & 5{,}200 & 2{,}600 \\ 7{,}700 & 8{,}000 & 7{,}550 & 4{,}400 \\ 5{,}700 & 5{,}600 & 5{,}500 & 3{,}200 \end{bmatrix}$
>
> $C11 = (150\cdot 15)+(175\cdot 14)+(1{,}000\cdot 3) = 7{,}700$
> $C22 = (0\cdot 0)+(0\cdot 0)+(1{,}300\cdot 8) = 10{,}400$
> $C33 = (150\cdot 12)+(175\cdot 10)+(1000\cdot 4) = 7{,}550$
> $C44 = (100\cdot 9)+(150\cdot 6)+(700\cdot 2) = 3{,}200$

Extension

Suppose a 3% tax must be paid on all rental income. Students can be asked to perform scalar multiplication on matrix A to determine how much tax should be charged in addition to the rental rate.

$$0.03 \cdot [A] = 0.03 \cdot \begin{bmatrix} 150 & 175 & 1{,}000 \\ 0 & 0 & 1{,}300 \\ 150 & 175 & 1{,}000 \\ 100 & 150 & 700 \end{bmatrix} = \begin{bmatrix} 4.50 & 5.25 & 30 \\ 0 & 0 & 39 \\ 4.50 & 5.25 & 30 \\ 3 & 4.50 & 21 \end{bmatrix}$$

Student Solutions

1. $A = \begin{bmatrix} 150 & 175 & 1{,}000 \\ 0 & 0 & 1{,}300 \\ 150 & 175 & 1{,}000 \\ 100 & 150 & 700 \end{bmatrix}$

2. The two zeros represent the weeknight rate and the weekend rate during the summer. The zeros are used as placeholders in the matrix because during the summer, the condo only rents by the week.

3. $B = \begin{bmatrix} 15 & 0 & 12 & 9 \\ 14 & 0 & 10 & 6 \\ 3 & 8 & 4 & 2 \end{bmatrix}$

4. The rows in the matrix represent the numbers of weeknights, weekend nights, and weeks the condo was rented. The columns represent the four seasons: spring, summer, fall, and winter.

5. It is possible to multiply the two matrices together because matrix A has 4 rows and matrix B has 4 columns.

6. The resulting matrix would be 4 × 4 because matrix A has 4 rows and matrix B has 4 columns.

7.
$$[A]\cdot[B] = \begin{bmatrix} 150 & 175 & 1{,}000 \\ 0 & 0 & 1{,}300 \\ 150 & 175 & 1{,}000 \\ 100 & 150 & 700 \end{bmatrix} \cdot \begin{bmatrix} 15 & 0 & 12 & 9 \\ 14 & 0 & 10 & 6 \\ 3 & 8 & 4 & 2 \end{bmatrix} = [C] \quad [C] = \begin{bmatrix} 7{,}700 & 8{,}000 & 7{,}550 & 4{,}400 \\ 3{,}900 & 10{,}400 & 5{,}200 & 2{,}600 \\ 7{,}700 & 8{,}000 & 7{,}550 & 4{,}400 \\ 5{,}700 & 5{,}600 & 5{,}500 & 3{,}200 \end{bmatrix}$$

8. The rows and the columns could be labeled the same: spring, summer, fall, and winter.

9.
	Spring	Summer	Fall	Winter
Spring	7,700	8,000	7,550	4,400
Summer	3,900	10,400	5,200	2,600
Fall	7,700	8,000	7,550	4,400
Winter	5,700	5,600	5,500	3,200

The numbers highlighted represent the amount of rent collected in each of the seasons.

10. To find the total amount of rent collected during the first year, add the amounts collected in the four seasons. The total amount collected during the first year was $28,850.

TI-Nspire Navigator Opportunities

Note 1
Question 1, *Quick Poll* and *Live Presenter*
Use Quick Poll for students to submit their matrix (make sure students insert a math box by pressing [ctrl] [M] before entering their matrix). The results of question 1 can help identify students who are having trouble and possible need differentiated instruction. Use Live Presenter on page 1.6 to clarify and answer questions regarding the set-up of the matrix.

Note 2
Question 1, *Quick Poll* and *Live Presenter*
Use Quick Poll for students to submit their matrix (make sure students insert a math box by pressing [ctrl] [M] before entering their matrix). The results of question 3 can help identify students who are having trouble and possible need differentiated instruction. Use Live Presenter on page 1.11 to clarify and answer questions regarding the set-up of the matrix. It is interesting to note to students that if the given data were in a matrix as given, then the matrix they wrote would be the "transposition" of the data matrix on page 1.8. This was done to line-up the correct units in the multiplication of the two matrices in question 7.

Note 3
Problem 3, *Class Capture*
You may choose to use Class Capture to monitor student progress as they use their handhelds to multiply the two matrices.