FRE 430 Spatial Data Science, Winter 2026

Lab 0: Matrices, Coordinate Systems
Solutions

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Jan. 6, 2026

About this lab

Due: Jan. 13, 2025 at 9:30 a.m.

- When referring to computer commands and files, `I will use this font`.
- You may talk with other students about the lab, but each student is responsible for doing all exercises in the lab themselves and turning in their own write up.
- Please submit this lab to Canvas as `LASTNAME-Lab0.pdf`. PDFs can be generated by scans or pictures taken of handwritten pages. Many iOS and Android apps can generate PDFs from pictures taken by the phone. One option is Genius Scan (for iOS or Android).
- If you think there is an error or something is unclear, let us know right away.
- Thanks to Solomon Hsiang for sharing materials for this lab.

1 Review of vectors and matrices

Following our notation in class, let

$$a = 1$$

$$b = 2$$

$$c = 50$$

$$d = 63$$

1. Let vector $\overrightarrow{r} = [a, b]$. Write out $\overrightarrow{r}$ in numbers. $\overrightarrow{r}$ = [1,2]
2. Write out $\overrightarrow{r}'$. $\overrightarrow{r}' = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$
3. Write out $\overrightarrow{r} + \overrightarrow{r}$. [2,4]
4. Let vector $\overrightarrow{v} = [c, d]$. Write out $\overrightarrow{v}$. [50, 63]
5. Write out $\overrightarrow{v} + \overrightarrow{r}$. [51, 65]
6. Write out $\overrightarrow{v} + \overrightarrow{r}'$. The dimensions do not match so we cannot compute this.
7. $\mathbf{A} = [\overrightarrow{r}', \overrightarrow{v}']$ is a 2 x 2 matrix. Write it out. $\mathbf{A} = \begin{bmatrix} 1 & 50 \\ 2 & 63 \end{bmatrix}$
8. Write out $\mathbf{A}'$. $\mathbf{A}' = \begin{bmatrix} 1 & 2 \\ 50 & 63 \end{bmatrix}$
9. If we write $2 \times \overrightarrow{v}$, that means you should multiply each element in $\overrightarrow{v}$ by 2. Write out $2 \times \overrightarrow{v}$. $2\overrightarrow{v}$ = [100, 126]
10. Write out $2 \times \mathbf{A}$. $2\mathbf{A} = \begin{bmatrix} 2 & 100 \\ 4 & 126 \end{bmatrix}$
11. Write out the set $\tilde{S} = \{\mathbf{A}, [\overrightarrow{r}, \overrightarrow{v}]\}$. $\tilde{S} = \left\{ \begin{bmatrix} 1 & 50 \\ 2 & 63 \end{bmatrix}, [1, 2, 50, 63] \right\}$
12. Write out the set $\tilde{S} = \{\mathbf{A}, \mathbf{A}'\}$. $\tilde{S} = \left\{ \begin{bmatrix} 1 & 50 \\ 2 & 63 \end{bmatrix}, \begin{bmatrix} 1 & 2 \\ 50 & 63 \end{bmatrix} \right\}$
13. Write the matrix $\mathbf{B} = \begin{bmatrix} 2 & 4 \\ 150 & 189 \end{bmatrix}$ in terms of $\overrightarrow{v}$ and $\overrightarrow{r}$. $\mathbf{B} = \begin{bmatrix} 2\overrightarrow{r} \\ 3\overrightarrow{v} \end{bmatrix}$
14. If we write $\mathbf{A}[i, j]$, it means we to are referring to a specific element in $\mathbf{A}$. The first argument (i) refers to the row in $\mathbf{A}$ that we want to look at, and the second argument (j) refers to the column we want to look at. So if we write $\mathbf{A}[1, 2]$, it means we want to look at the number in the first row and in the second column (think of "Battleship"). We always start counting rows and columns from the upper left corner of the matrix. What is $\mathbf{A}[1, 2]$? $\mathbf{A}[1, 2] = 50$
15. What is $\mathbf{A}[2, 1]$? $\mathbf{A}[2, 1] = 2$
16. If we replaced $\mathbf{A}[1, 2]$ with a "5", what would $\mathbf{A}$ look like? $\mathbf{A} = \begin{bmatrix} 1 & 5 \\ 2 & 63 \end{bmatrix}$

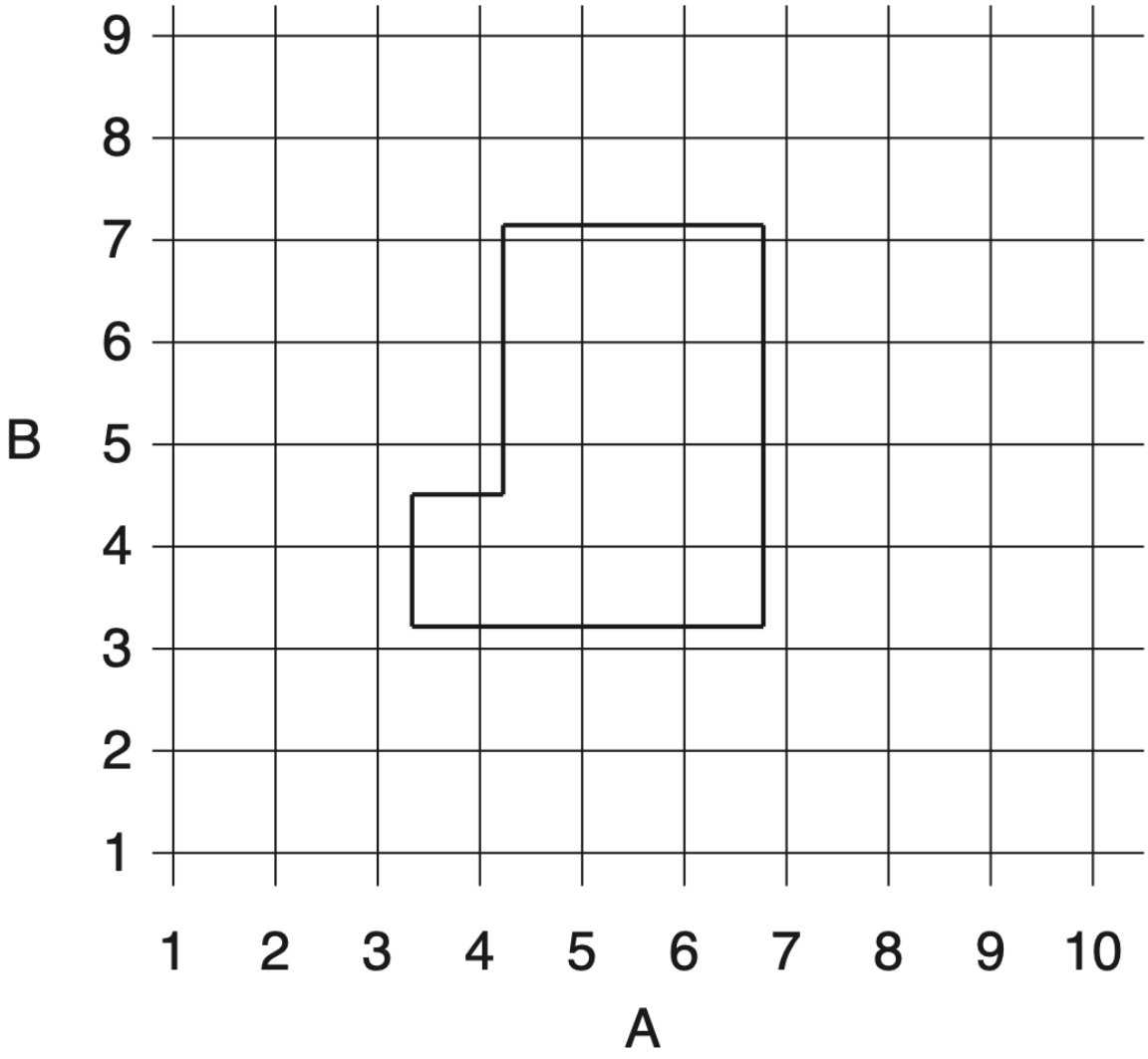
2 Coordinate systems

1. Create a table like the following one to list the corners of $\tilde{G}$ using the various coordinate systems depicted on the following pages. Make sure that both the location and shape of the object are preserved when you list the corners in each coordinate system. Use 1 decimal point of accuracy (we will allow for ± 0.5 in measurement error when grading).

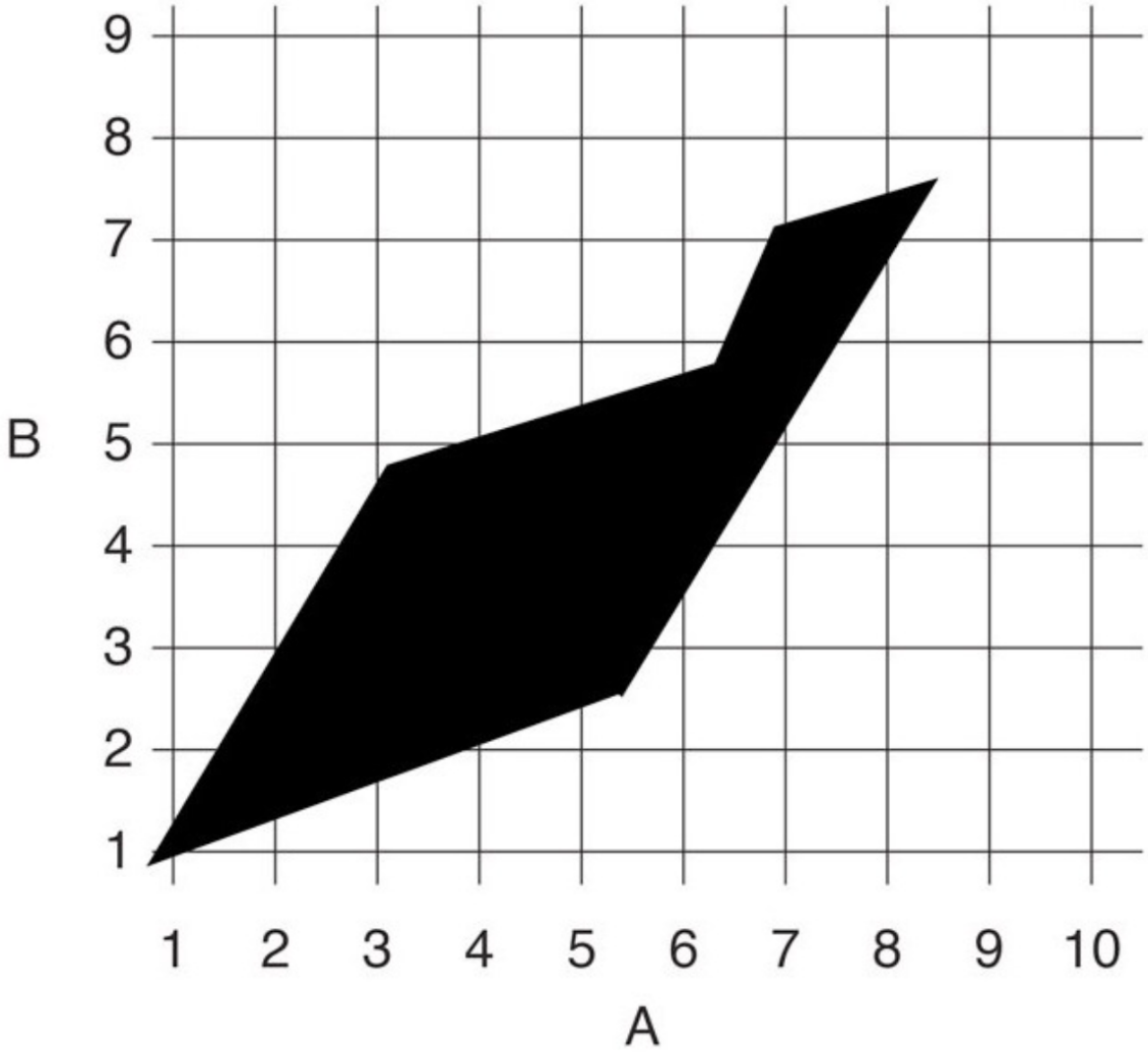
Coord. System	1	2	3	4	5	6
"Cartesian XY"	[3.2,3.2]	[3.2,6.7]	[4.5,6.7]	[4.5,5.9]	[7.1,5.9]	[7.1,3.2]
"Cartesian IJ"	[6.8,3.2]	[3.3,3.2]	[3.3,4.5]	[4.1,4.5]	[4.1,7.1]	[6.8,7.1]
"Skew"	[5.4,2.5]	[8.5,7.6]	[6.9,7.1]	[6.3,5.8]	[3.1,4.8]	[0.6,0.9]
"Polar rectangular"	[3.9,6.2]	[2.8,7.7]	[2.8,0.2]	[1.5,7.8]	[1.6,2.5]	[3.9,4.0]
"Seuss"	[1.3,2.3]	[3.2,1.0]	[3.8,1.2]	[2.8,1.5]	[3.5,3.6]	[2.6,4.7]

2. Do you prefer a specific system? Why? [Up to you!]

3a)



3b)



3c)