Math 232 – Computing Assignment 2

Due Date: October 28th, at 10:55pm.

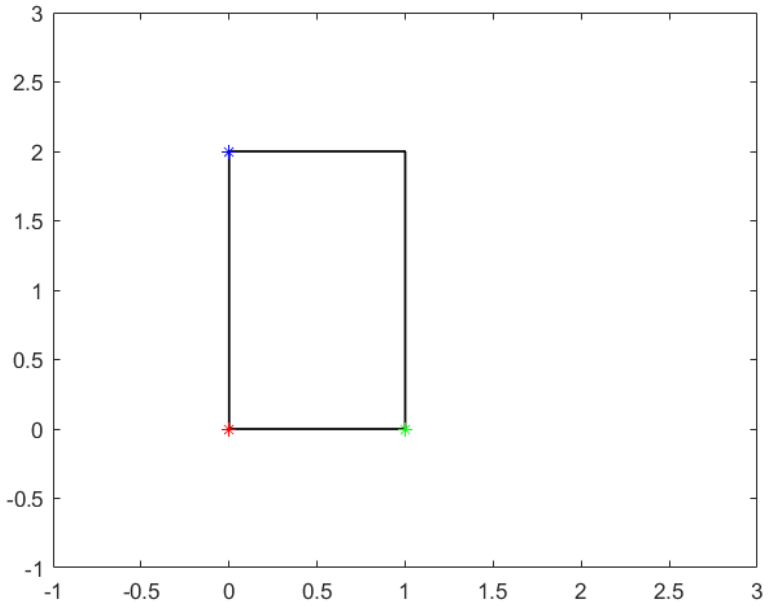
You must upload to Crowdmark both your code (i.e., the Matlab or Python or other programming app commands you used) and your report (i.e, answers to the problems here). The assignment is due at 10:55pm. I have set the due time in Crowdmark to 11:00pm and if Crowdmark indicates that you submitted late, you will be given 0 on the assignment.

- Please read the **Guidelines for Computing Assignments in Canvas** first.
- Keep in mind that Canvas discussions are open forums.
- Acknowledge any collaborations and assistance from colleagues/TAs/instructor.

Programming Preamble:

This bit of Matlab code draws a rectangle. It also places 3 coloured stars at 3 of the corners.

```
x1=0; x2=1;
y1=0;
y2=2;
x = [x1, x2, x2, x1, x1];
y = [y1, y1, y2, y2, y1];
plot(x, y, 'k-', 'LineWidth', 1);
hold on;
>> P=[0 1 1 0;0 0 2 2];
>> plot(P(1,1),P(2,1),'r*');
>> plot(P(1,2),P(2,2),'g*');
>> plot(P(1,4),P(2,4),'b*');
>> axis([-1 3 -1 3]);
```



Computing Assignment

Required submission: 1 page PDF document with your answers to the problems here, and a PDF document with your Matlab or Python code (exported to a .pdf file), both uploaded to Crowdmark (so, upload 2 things - a one page report and the PDF of your code.).

This computing assignment is designed so that you will demonstrate to yourself that matrices operate on vectors in $\mathbb{R}^2$ in a way that we can observe geometrically.

1. **Part 1 - Geometric transformations**

   - Vectors

     First, choose 2 vectors (note that in the code above these two vectors are $(0, 0)$ and $(1, 2)$) the terminal points of which are used to form a rectangle. Plot this rectangle using code similar to that provided above. Then choose TWO different matrices each of which performs a single geometric operation of your choice. In both cases, multiply your 2 vectors by these matrices and plot the resulting rectangles. Include one plot in your report which shows your original rectangle and your two transformed rectangles. Include the matrices you used to do the transformation.

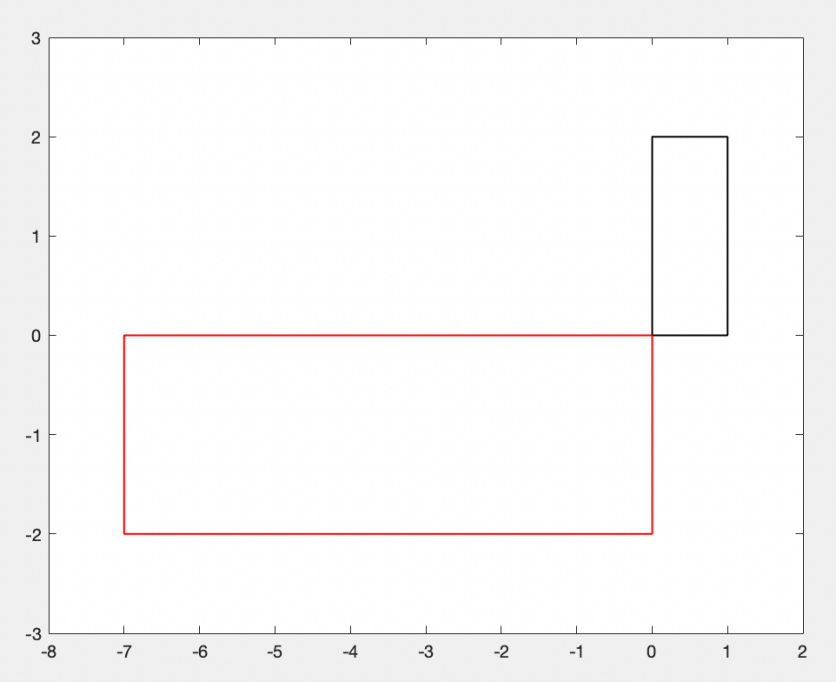
   - Composition

     Verify the result of Problem A6 in Section 3.3 of the text; that the two compositions of a vertical shear and a stretch in the y direction, do not commute. Do this by plotting the image of the unit square with corners at $(1, 1), (2, 1), (2, 2), (1, 2)$. Then plot the results of applying the COMPOSITION of the two operations (vertical shear and stretch) in both orders and showing that the resulting shape depends on the order in which the operations are applied. Corroborate your 'experimental proof' of the non-commutability of these transformations by referring to Theorem 3.2.5 of the text (i.e., by considering the associated matrices).

Part 2 $\longrightarrow$

2. **Part 2 - Manipulating an Image**

- Consider the following picture:



- Find the matrix that transforms the black rectangle into the red rectangle. Look at the diagram and observe what has happened to the black rectangle. Form the matrices that do these operations; there are two. Multiply these matrices in the correct order to get the transformation matrix A. Experimentally verify that you can plot the black rectangle yourself and then multiply the vectors that describe the opposite vertices by A and obtain and plot the red rectangle. Include the matrices you used to do this in your report.