

# Math 251: Computational Lab 1

Fall 2019, Sections 1-3

Instructor: Matt Charnley  
Recitation Instructor: Some TA  
Due Date: September 1, 2019

## Introduction

You are encouraged to discuss this assignment with other students and with the instructor/recitation instructor, but the work you hand in should be your own. See the website

<http://math.rutgers.edu>

for more information as well as helpful background information and commands for completing the assignment.

This lab covers the basics of vectors and planes in  $\mathbb{R}^3$ . You will be writing code to analyze vectors and compute with them, as well as drawing plots to illustrate your results.

## Your Task

For this assignment, you will be given individualized data by your instructor, which will consist of three points,  $p$ ,  $q$ , and  $r$  in  $\mathbb{R}^3$ . You will then need to

- Compute the two vectors  $\vec{pq}$  and  $\vec{pr}$  and compute the angle between these vectors in two different ways,
- Draw the triangle  $T$  formed by  $p$ ,  $q$ , and  $r$ , as well as the vector  $\vec{v} = \vec{pq} \times \vec{pr}$  starting from  $p$ , showing several pictures to illustrate the relationship between  $\vec{v}$  and this triangle, and
- Find the equation of the plane containing  $p$ ,  $q$ , and  $r$ .

## Deliverable

Your code should consist of the following:

1. Storing the three points  $p$ ,  $q$ , and  $r$ . As a general rule, you should always be storing your inputs and using variables instead of just carrying numbers from one step to the next. This will make the underlying process more clear for you (and help you with exams later on).
2. Compute the vectors  $\vec{pq}$  and  $\vec{pr}$ , and finding the angle between these vectors in two ways, one using the dot product and a second using the cross product.

3. Compute  $\vec{v} = \vec{pq} \times \vec{pr}$  and describe **in words** how  $\vec{v}$  relates to the vectors  $\vec{pq}$  and  $\vec{pr}$ . You can include this in a comment within the code.
4. Two plots (Figure 1 and Figure 2) that draw the triangle  $T$  made up of points  $p$ ,  $q$ , and  $r$ , and a line segment coming from  $p$  in the direction of  $\vec{v}$  to illustrate your result from the previous part. You'll want to have a different viewing angle for the two plots so that they show different views of the image.
5. A calculation of the equation of the plane containing  $p$ ,  $q$ , and  $r$ . You need to display the equation in all three forms; one vector and two scalar forms. (You can do this in a comment if needed)

Print all of your code (after removing all of the incorrect lines) and the desired images from above and put them into a single stapled packet. This assignment is due on **September 1, 2019** in recitation.

## Tips

As far as good programming practices are concerned, you may find it helpful to write methods to compute dot products and cross products. That is, a method that takes in two vectors and returns the corresponding product. You'll need to use that several times over the course of this assignment, so it may be useful to only need to write them once and reuse them. It also might be nice to have one that computes the norm/length of a vector, if that doesn't already exist in your computer system.

## Rubric

This lab is worth a total of 15 points.

- 3 points for including the supporting code for all of the points below.
- 1 point each (3 total) for calculating  $\vec{pq}$ ,  $\vec{pr}$  and  $\vec{v}$ .
- 1 point each (2 total) for correctly computing the angle between the vector in two ways.
- 1 point for saying, in words, what the relationship between  $\vec{v}$  and  $\vec{pq}$  and  $\vec{pr}$  is.
- 3 points for drawing a picture of the triangle  $\Delta PQR$  (1 point) and the vector  $\vec{v}$  (1 point), with at least one picture that accurately shows the relationship (1 point).
- 3 points for writing out the three forms of the equation of the plane containing  $p$ ,  $q$ , and  $r$ .