

# CPSC 314 Assignment 0



Term: January 2011, Instructor: Wolfgang Heidrich, [heidrich@cs.ubc.ca](mailto:heidrich@cs.ubc.ca), <http://www.ugrad.cs.ubc.ca/~cs314>

**Due: January 10 in class**

## Assignment 0.1: Vector and Matrix Operations (19 Points)

Let  $\mathbf{a} = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$ ,  $\mathbf{b} = \begin{pmatrix} -1 \\ 3 \\ 0 \end{pmatrix}$ , and  $c = 3$ .

a) for each of the following expressions, either compute the result, or explain why the expression does not make sense.

- $\mathbf{a} \cdot \mathbf{b}$
- $\mathbf{b} \times \mathbf{a}$
- $\mathbf{a}\mathbf{b}^T$
- $\mathbf{a} \times \mathbf{a}$
- $\mathbf{a}^T \mathbf{b}$
- $\mathbf{a} \times c$
- $\mathbf{b}^T \mathbf{a}$
- $c\mathbf{a} \times \mathbf{b}$
- $\mathbf{a}\mathbf{b}$
- $\mathbf{a}^T c\mathbf{b}$
- $\mathbf{a} \times \mathbf{b}$

b) which of the above expressions is identical to  $(\mathbf{b} \cdot \mathbf{a})$

c) give a non-zero vector  $\mathbf{d}$  such that  $(\mathbf{a} \cdot \mathbf{d}) = 0$ . Is the answer unique?

d) compute a normalized version  $\hat{\mathbf{a}}$  of  $\mathbf{a}$

e) Suppose that three vectors in 3D all have unit length and are all orthogonal to each other. If you know that  $\mathbf{a} \times \mathbf{b} = \mathbf{c}$ , then what is  $\mathbf{a} \times \mathbf{c}$ ? Assume a right-handed coordinate system.

f) Let  $\mathbf{A} = \begin{pmatrix} 1 & 0 & -2 \\ 0 & 2 & 4 \\ 0 & 0 & 1 \end{pmatrix}$ , and  $\mathbf{B} = \begin{pmatrix} 1 & 1 & -1 \\ -1 & 2 & -1 \\ 0 & 0 & 1 \end{pmatrix}$ . Compute  $\mathbf{C} = \mathbf{AB}$

g) What is  $(\mathbf{AB})^T$  expressed in terms of  $\mathbf{A}^T$  and  $\mathbf{B}^T$ ?

h) Simplify the expression  $\mathbf{A}^T \mathbf{A} \mathbf{B} \mathbf{B}^{-1} \mathbf{A}^{-1}$ .

## Assignment 0.2: Singular Matrices (6 Points)

Circle each of the following matrices that does *not* have an inverse:

$$\begin{pmatrix} 2 & 4 \\ 1 & 2 \end{pmatrix} \quad \begin{pmatrix} 3 & 8 \\ -6 & 7 \end{pmatrix} \quad \begin{pmatrix} -3 & 6 \\ 9 & 27 \end{pmatrix} \quad \begin{pmatrix} 5 & -2 & 1 \\ 4 & 9 & -3 \end{pmatrix} \quad \begin{pmatrix} 4 & 1 \\ 2 & 2 \end{pmatrix} \quad \begin{pmatrix} 1 & 0 & 1 \\ 0 & 2 & 2 \\ 2 & 1 & 3 \end{pmatrix}$$

## Assignment 0.3: 2D Integrals (5 Points)

**Hint:** use geometric intuition for this question, rather than brute-force integration...

What is the value of the integral

$$\int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} f(x, y) dx dy$$

where

$$f(x, y) = \begin{cases} \sqrt{1 - x^2 - y^2} & ; x^2 + y^2 < 1 \\ 0 & ; \textit{else} \end{cases}$$

## Assignment 0.4: Linear Interpolation (2 Points)

On March 15, the temperature was 5°C. On March 27, the temperature was 17°C. What was the temperature on March 23, assuming a linear variation of temperature over time?

## Assignment 0.5: Coding (8 Points)

This is an exercise to get you started with the programming environment and OpenGL. OpenGL is not installed on all of the CS undergrad machines. The code provided here has been tested on the Linux machines in 005. This is also the lab where the lab sessions are held, **and where the assignments will be graded!**.

For this assignment, you are provided some code that is located on the course web page. The TAs can help you to get started in the lab.

- read the form on the following page of this text
- download and untar A0-Code.tar.gz
- run “make” to build the executable
- start the program with the command “./openGLDemo”
- change the program to make the triangle green at the top, and white at the bottom
- add a second triangle that cuts through the first one at a right angle, to get a crude approximation of something that looks a bit like a Christmas tree. The original triangle sits in the plane defined by  $z = 0$ . Your new triangle should sit in the plane defined by  $x = 0$ .
- make the “q”-key quit the program. Calling the function “exit(0)” will accomplish this.
- make the space bar toggle the animation on and off.
- make the scene rotate around the x-axis rather than the y-axis. Note how can no longer see the second triangle. Why?

### Handin Instructions

- Fill in a copy of the form on the next page, and bring it to class on Monday, January 10. **We will not mark assignments where the form is missing.**
- Create a directory called cs314 your home directory.
- For assignment 0, create a sub-folder called assn0 in the cs314 directory, and put all files you want to submit into this directory. For the current assignment, there should be only one file: openGLDemo.cpp.
- The assignment should be handed in with the exact command:

```
handin cs314 assn0
```

Please refer to the man page of the handin command for details.

## Collaboration Policy

In this course, graded assignments are intended to be solved by individual students. Each student must submit their own individual solution.

If you have collaborated with other students on the solution to this assignment, this fact needs to be disclosed in the form below. **Note that disclosing a collaboration may result in reduced marks.** Likewise, if external resources (other than the course web pages and text book) were used for solving the assignment, they need to be listed below. **Failure to disclose a collaboration or external resources constitutes an act of academic misconduct, and will be reported to the dean.**

### Declaration

I hereby declare that I have read and understood the above statement.

Name:

Student ID:

Signature and Date:

I have used the following external resources:

I have collaborated with the following individuals (explain degree of collaboration):