

ECE 472 Robotics and Vision
Prof. K. Dana
Homework 1: Linear Algebra Review

*Directions: Hand in one pdf file name **hw1.pdf** (from your written work) and for the last question hand in a file named **hw1.py** that can be run in the class's Docker environment.*

1. In this exercise, you will use the code *hello.py* (adapted from the google python exercise). The code will say hello to the first input argument and display the image found at the filename given by the second input argument. Your program will be run using "python hello.py samplename testing.jpg". It should say "Hello there samplename" and then display the image in testing.jpg. *Nothing needs to be handed in for this question.*

```
#!/usr/bin/env python
import numpy as np
import cv2
from matplotlib import pyplot as plt

# import modules used here -- sys is a very standard one
import sys

# Gather our code in a main() function
def main():
    print 'Hello there', sys.argv[1]
    # Command line args are in sys.argv[1], sys.argv[2] ...
    # sys.argv[0] is the script name itself and can be ignored
    img = cv2.imread('testing.jpg',1)
    # Display with matplotlib
    plt.imshow(img, interpolation = 'bicubic')
    plt.xticks([]), plt.yticks([])  # to hide tick values on X and Y axis
    plt.show()
    # Close the window will exit the program
    cv2.destroyAllWindows()

# Standard boilerplate to call the main() function to begin
# the program.
if __name__ == '__main__':
    main()
```

2. Are the following vectors basis vectors for \mathbb{R}^3 ? Why or why not?

$$w_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, w_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, w_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad (1)$$

3. Do you think the following can also be basis vectors for \mathbb{R}^3 ? Why or why not?

$$t_1 = \begin{bmatrix} 0.707 \\ -0.707 \\ 0 \end{bmatrix}, t_2 = \begin{bmatrix} -0.707 \\ 0.707 \\ 0 \end{bmatrix}, t_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad (2)$$

4. Do the following vectors span \mathbb{R}^3 ? Why or why not?

$$w_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, w_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, w_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, w_4 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \quad (3)$$

5. Given the following coordinates for measurement points, solve problem of fitting a line to these points using linear least square estimation. You are to solve the problem **two** ways: (1) by hand, (2) with python. Be sure to set up the problem in the form $Aq = b$ by defining A and b . Then compute the parameter vector q using least squares estimation. $x_1 = 0, y_1 = 1$

$$x_2 = 1, y_2 = 3.2$$

$$x_3 = 1.9, y_3 = 5$$

$$x_4 = 3, y_4 = 7.2$$

$$x_5 = 3.9, y_5 = 9.3$$

$$x_6 = 5, y_6 = 11.1$$

6. Write a python program to test the conjecture that there are only 2 independent columns in the matrix below.

$$A = \begin{bmatrix} 4.29 & 2.2 & 5.51 \\ 5.20 & 10.1 & -8.24 \\ 1.33 & 4.8 & -6.62 \end{bmatrix}$$