

CSci 4270 and 6270  
Computational Vision,  
Spring Semester, 2021  
Lecture 03 Exercise  
Due: Sunday, January 23, 2022 at 5 pm EST

**Problem**

1. For **unit vectors**  $\hat{x}$  and  $\hat{y}$  in N dimensional space, the *square Euclidean distance* between the vectors is  $\|\hat{x} - \hat{y}\|^2$  while the *cosine distance* is  $\cos \theta = \hat{x} \cdot \hat{y}$ . Give a derivation showing that

$$\|\hat{x} - \hat{y}\|^2 = 2(1 - \cos \theta).$$

Note: all submissions must be pdf files. You may write the solution by hand but you must scan it or take a low-res (but still clear) picture. Do NOT submit a high resolution photo! For homework assignments, written solutions must be typeset, preferably with LaTeX (get an Overleaf account).

2. **Important Note:** because we got behind we didn't cover enough material for this problem to be due two days after class. Therefore, it is now a "practice problem" and will not count toward your grade. The Submittity site will still accept submissions and you can still see if your answer would have been correct.

The supplied code reads in a list of points in two dimensions and returns it as an array. Complete the code by finding and printing the first principle component vector. Use either `np.linalg.eigh` or `np.linalg.svd` to do so. Print the vector as two values on Two lines, accurate to three decimal places. Note that there is a sign ambiguity to the vectors, such that  $x_1, y_1$  and  $-x_1, -y_1$  are equally correct. Resolve this ambiguity by ensuring that  $x_1$  is positive (and don't worry about the case of  $x_1 \approx 0$ ).

The outputs from my code on the two example files are

```
% python prob2_sol.py pts_v1.txt
0.454
0.891
```

and

```
% python prob2_sol.py pts_v2.txt
0.962
-0.272
```