Ph 21 Homework 6

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1 Question 2.

I wrote general python code to compute the principle components.

```
def PCA(points):
    cov_mat = np.cov(points, rowvar=False)
    eigenvalues, eigenvectors = np.linalg.eig(cov_mat)
    order = np.argsort(-eigenvalues)
    eigenvalues = eigenvalues[order]
    eigenvectors = eigenvectors[:, order]
    return eigenvalues, eigenvectors
```

where "points" is the list of data points. The general outline is to take the co-variance of the inputted matrix and then to find the eigenvalues/eigenvectors for that co-variance. The eigenvectors are the principal components.

2 Question 3.

Next, I simulated linearly dependent data to test it out on. I simulated the data by randomly choosing an x and computing the y as a function of an arbitrary line. I added a random normal error to both components before adding it to matrix.

```
def getData():
    x = np.random.rand()
    array = [x + getError(), 5 * x + 3 + getError()]
    return np.array(array)

def getError():
    sigma = 0.05
    mu = 0
    return np.random.normal(mu, sigma)
```

For 10 points, the eigenvectors were

$$\begin{bmatrix} -0.18216338 \\ -0.98326828 \end{bmatrix}$$

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3 Question 4.

I used the camera problem from the paper to model a higher dimension problem. To get data from three different perspectives, I concatenated three matrices where each one had its own x and y measurements, all as a linear function of x. I set arbitrary slopes and y-intercepts for these three perspectives. My resulting eigenvectors for 10 data points in each perspective were

$$\begin{bmatrix} -0.00180946 \\ 0.23442404 \\ -0.209598 \\ 0.77714634 \\ 0.35306747 \\ -0.41532842 \end{bmatrix}$$

$$\begin{bmatrix} -0.02888357 \\ 0.67620242 \\ -0.66478171 \\ -0.26349676 \\ -0.08253573 \\ 0.15407339 \end{bmatrix}$$

$$\begin{bmatrix} -0.11204541 \\ -0.14859238 \\ -0.10827084 \\ 0.22069578 \\ 0.5000141 \\ 0.80927303 \end{bmatrix}$$

$$\begin{bmatrix} 0.40568455 \\ 0.6242625 \\ 0.63272841 \\ 0.04352614 \\ 0.08913925 \\ 0.18849616 \end{bmatrix}$$

$$\begin{bmatrix} -0.18130998 \\ 0.05863658 \\ 0.03447752 \\ 0.51456452 \\ -0.76935267 \\ 0.3252992 \end{bmatrix}$$

$$\begin{bmatrix} -0.88834398 \\ 0.26939568 \\ 0.3176121 \\ -0.10599637 \\ 0.13663009 \\ -0.08654757 \end{bmatrix}$$