Assignment 1

Due by September 19, 2019

1. Print four 512×512 images: *lenna.raw, mandrill.raw, Rloop.raw,* and *Whorl.raw* with size 3.2 by 3.2 inches *on the same page*, where the image data are located in

$$\text{http://www.cs.nthu.edu.tw/}{\sim}\text{cchen/CS4520/Data/X.raw}$$

where $X \in \{lenna,\ mandrill,\ Rloop,\ Whorl\}$.

2. Show that both Q_8 and Q_4 are orthogonal matrices, where

$$Q_8 = \frac{1}{2} \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ cos\frac{\pi}{16} & cos\frac{3\pi}{16} & cos\frac{5\pi}{16} & cos\frac{7\pi}{16} & cos\frac{9\pi}{16} & cos\frac{11\pi}{16} & cos\frac{13\pi}{16} & cos\frac{15\pi}{16} \\ cos\frac{2\pi}{16} & cos\frac{6\pi}{16} & cos\frac{10\pi}{16} & cos\frac{14\pi}{16} & cos\frac{18\pi}{16} & cos\frac{22\pi}{16} & cos\frac{26\pi}{16} & cos\frac{30\pi}{16} \\ cos\frac{3\pi}{16} & cos\frac{9\pi}{16} & cos\frac{15\pi}{16} & cos\frac{21\pi}{16} & cos\frac{27\pi}{16} & cos\frac{33\pi}{16} & cos\frac{39\pi}{16} & cos\frac{45\pi}{16} \\ cos\frac{4\pi}{16} & cos\frac{12\pi}{16} & cos\frac{20\pi}{16} & cos\frac{28\pi}{16} & cos\frac{36\pi}{16} & cos\frac{44\pi}{16} & cos\frac{52\pi}{16} & cos\frac{60\pi}{16} \\ cos\frac{5\pi}{16} & cos\frac{15\pi}{16} & cos\frac{25\pi}{16} & cos\frac{35\pi}{16} & cos\frac{45\pi}{16} & cos\frac{55\pi}{16} & cos\frac{65\pi}{16} & cos\frac{75\pi}{16} \\ cos\frac{6\pi}{16} & cos\frac{18\pi}{16} & cos\frac{30\pi}{16} & cos\frac{42\pi}{16} & cos\frac{54\pi}{16} & cos\frac{66\pi}{16} & cos\frac{78\pi}{16} & cos\frac{90\pi}{16} \\ cos\frac{7\pi}{16} & cos\frac{21\pi}{16} & cos\frac{35\pi}{16} & cos\frac{49\pi}{16} & cos\frac{63\pi}{16} & cos\frac{77\pi}{16} & cos\frac{91\pi}{16} & cos\frac{105\pi}{16} \end{bmatrix}$$

$$Q_4 = \frac{1}{\sqrt{2}} \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ cos\frac{\pi}{8} & cos\frac{3\pi}{8} & cos\frac{5\pi}{8} & cos\frac{7\pi}{8} \\ cos\frac{2\pi}{8} & cos\frac{6\pi}{8} & cos\frac{10\pi}{8} & cos\frac{14\pi}{8} \\ cos\frac{3\pi}{8} & cos\frac{9\pi}{8} & cos\frac{15\pi}{8} & cos\frac{21\pi}{8} \end{bmatrix} \approx \frac{1}{26} \begin{bmatrix} 13 & 13 & 13 & 13 \\ 17 & 7 & -7 & -17 \\ 13 & -13 & -13 & 13 \\ 7 & -17 & 17 & -7 \end{bmatrix}$$

3. Find the eigenvalues and their corresponding eigenvectors of matrices Q_8 and Q_4 in problem **2.**

4. Let X be the exponential distribution with mean 4, i.e., $f(x) = \frac{1}{4}exp(-x/4)$ for $0 \le x < \infty$, Simulate this distribution to generate 1024 floating-point numbers. *Report your estimated mean and estimated variance by MLE.*

5. Simulate $Y \sim N(128, 2500)$ to generate 1024 floating-point numbers. *Report your estimated mean and estimated variance by MLE.*

♣ Report **results only** for problems **2∼5.**