# Third Lab Assignment (Due by 3pm on Nov. 13)

Reference MATLAB tutorial, Lab 5, Lab 6 and Lab 7 code examples.

**Lab assignments**

**Assignment 1** Let $X$ be a continuous random variable, plot the probability density function $f(x)$ if

- $X$ is an exponential distribution, $X \sim Exp(\lambda)$, $\lambda = 0.5, 1, 2$
- $X$ is a normal distribution, $X \sim N(\mu, \sigma^2)$, where $(\mu, \sigma^2)$ are from {(-1, 1),(0, 1), (1, 1), (0, 4),(0, 16)}

For each of those two cases, you have to plot multiple curves, one for each of the probability density functions when the parameter is fixed. For example, for the exponential distribution, you have to plot the probability density functions for $Exp(0.5)$, $Exp(1)$, $Exp(2)$. Please use different colors (e.g., red, blue, black) for those curves and put those curves in one figure. Please analyze those curves in this figure and draw a conclusion for how does the curve changes when we increase (or decrease) the parameter value.

You have to submit:

1. MATLAB codes, which should be put in script files (.m)
2. Two figures, which should be in png format (.png)
3. Two observations (conclusions), which should be in a plain text file (.txt), or as a comment section inside script (.m) file.

**Assignment 2** Let $X$ be a continuous random variable, plot the distribution function $F(X)$ if

- $X \sim Exp(2)$
- $X \sim N(0, 1)$

For each of those distributions, you have to plot a figure, showing the distribution function.

You have to submit

- MATLAB codes, which should be put in script files (.m)
- Two figures, which should be in png format (.png)

Please submit both of your MATLAB codes and the plotted figure.

**Assignment 3** Let X be a continuous random variable, generate $10^5$ samples if

- $X \sim Exp(2)$
- $X \sim N(0, 2)$

You can use the MATLAB function random to generate data points from a given distribution. Please check the help or doc command in order to use the random function correctly. Please plot those samples by using hist function. You can check its usage by using help hist or doc hist. You have to submit

- MATLAB codes, which should be put in script files (.m)
- Two figures, which should be in png format (.png)

**Assignment 4** Let $X$ be a discrete random variable. For each of the following cases when

- $X$ is a Binomial distribution, $X \sim Bin(n, p)$, $n = 100$, $p = 0.5$,
- $X$ is a Geometric distribution, $X \sim Geo(p)$, $p = 0.5$,

you have to compute the TRUE and EMPIRICAL values for the mean and variance of X. For the true values, you can calculate them manually or you can first generate such a distribution with the specific parameters and then use the functions provided by the MATLAB to compute its mean and variance. For the empirical values, you first randomly generate N samples from such a distribution, and then use the mean and var functions to compute the empirical mean and variance on those samples, respectively. You have to repeat this process for 10 times and obtain the average value of the computed empirical mean and variance over the 10 repeats. Please experimented with $N = [5, 10, 50, 100, 500, 1000, 5000]$ and then plot a 2D figure, where x-axis denotes $N$ and the y-axis denotes the empirical values for mean or variance. Finally, you have to add a line of the true values for the mean or variance. Please use different colors for the true and empirical values. For each case, you have to submit

a) MATLAB codes, which should be put in script files (.m);

b) Two figures, which should be in png format (.png). One is for the empirical and true mean values and the other is for the empirical and true variance values.

**Assignment 5** Let $X$ be a continuous random variable. For each of the following cases when

1. $X$ is an Exponential distribution, $X \sim Exp(\lambda)$, $\lambda = 2$,
2. $X$ is a Normal distribution, $X \sim N(\mu, \sigma^2)$, $\mu = 0$, $\sigma = 1$,

you have to compute the TRUE and EMPIRICAL values for the mean and variance. For the true values, you can manually compute them or you can first generate such a distribution with the specific parameters and then use the functions provided by the MATLAB to compute the true value of its mean and variance. For the empirical values, you first randomly generate N samples from such a distribution, and then use the mean and var functions to compute the empirical mean and variance on those samples, respectively. You have to repeat this process for 10 times and obtain the average value of the computed empirical mean and variance over the 10 repeats. Please experiment with $N = [5, 10, 50, 100, 500, 1000, 5000]$ and then plot a 2D gure, where x-axis denotes N and the y-axis denotes the empirical values for mean or variance.

Then, you have to add a line of the true values for the mean or variance. Please use different colors for the true and empirical values. For each case, you have to submit

a) MATLAB codes, which should be put in script files (.m);

b) Two figures, which should be in png format (.png). One is for the empirical and true mean values and the other is for the empirical and true variance values.