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Date: October 27, 2019
Assignment: TMATH 390 R Lab 4 Document.

Objectives
1. Use R to calculate probabilities for the normal and exponential distributions.
2. Use R to draw random numbers from the normal and exponential distributions.

```
> #OBJECTIVES:
> #1. Use R to calculate probabilities for the normal and exponential distrib
utions.
> #2. Use R to draw random numbers from the normal and exponential distributi
ons.
> ###########################################################################
########################
```

C1.
> #Submitted R Script.

```
> #--------------------------------------------------------------------------
> ## The function dnorm returns the height of the normal density
> # function at a given value of x, for a normal distribution with
> # a given mean and standard deviation (sd)
> dnorm(x = 1,mean = 0, sd = 1)
[1] 0.2419707
```

C2. (1) For what special normal distribution does the above call return the value of the normal density function?

The standard normal distribution, where:
$\mu = 0$, and $\sigma = 1$.

C3. (1) Report the result of the dnorm command as executed above, and compare it to the value obtained from a hand-calculation of the normal density function with the same mean and standard deviation.

```
dnorm(x = 1,mean = 0, sd = 1)
[1] 0.2419707
```

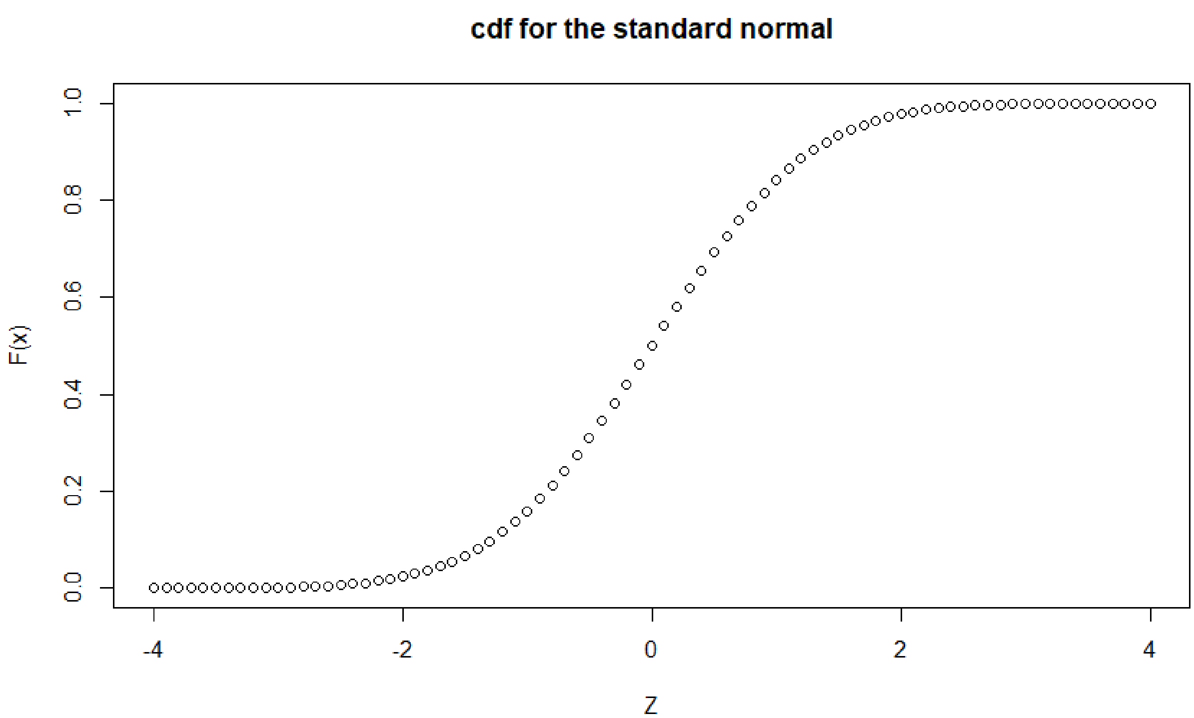
<u>By hand and calc:</u>

$$\frac{e^{-0.5}}{\sqrt{2\pi}} = 0.2419707245$$

We can also use R to determine the cumulative area under the curve for the normal distribution using the pnorm ("p" for probability) function. This returns the value of the cumulative distribution function (cdf) for the normal distribution. This is especially helpful because we cannot evaluate the integral analytically, we have to solve it numerically. R does this for us.

C4. (1) Create a graph of the cumulative distribution function for the standard normal distribution. Use the code below to help you.

```
#Creating a sequence of x values for the graph
> #starting at -4, to 4, by 0.1
> x.vals=seq(-4,4,0.1)
> # Creating a vector of the corresponding values for the cdf
> y.vals=pnorm(x.vals,mean=0,sd=1)
> #Making the graph
> plot(x.vals,y.vals,xlab="Z",ylab="F(x)",main="cdf for the standard normal")
```



C5. (1) Describe the shape of the graph you created in C4.

The graph has point symmetry about where it intersects z=0.

The graph is oddly symmetrical.

The graph increases from -4 to 4, from left to right.

The lowest range is 0.0, and the highest is 1.0, corresponding to the probabilities defined by cdf($z_{minimum}$= -4) = 0 and cdf($z_{maximum}$ = 4) = 1.0

C6. (2) For each R command below, report the result (include the command in your report). Compare the result to the probability obtained using the standard normal table.

```
> round(pnorm(2.37, mean=0, sd=1), 5)
[1] 0.99111
```

Command gets the area for the standard normal distribution, below given z value = 2.37 and then rounds it to 5 decimal places

From the table, value is 0.9911, which is to 4 decimal places.

```
> pnorm(-0.5, mean=0, sd=1)
[1] 0.3085375
```

This is the area below the z value =-0.5, given to 7 decimal places.

From table, value is 0.3085

```
> pnorm(2.37, mean=0, sd=1) - pnorm(-0.5, mean=0, sd=1)
[1] 0.6825684
```

From table, this area would be:

0.9911-0.3085 = 0.6826

```
#Command gets the area for the normal distribution, at x value < 18
> #at default 7 decimal places
> pnorm(18, mean=22, sd=4.5)
[1] 0.1870314
> #Confirming with standard normal distribution
> pnorm(-0.88888889, mean=0, sd=1)
[1] 0.1870314
```

From Table at z=-0.89: Area is 0.1867

```
> #Command gets the area for the normal distribution, at x value < 18
> #at default 7 decimal places
> pnorm(23, mean=22, sd=4.5)
[1] 0.5879296
> #Confirming with standard normal distribution
> pnorm(0.222222222, mean=0, sd=1)
[1] 0.5879296
```

From Table at z=0.22: Area is 0.5871

We are often also interested in determining a normal distribution quantile associated with a given probability. We use the r function qnorm ("q" for quantile) to return the normal quantile associated with a given cumulative probability.

C7. (1) For the R command below, report the result (include the command in your report). Compare the result to the quantile obtained using the standard normal table.

```
#Compare the result to the quantile obtained using the standard normal table.
> qnorm(0.25, mean=0, sd=1)
[1] -0.6744898
```

```
0.2514 is at z = -0.67
```

```
This value, -0.67 is the closest approximation to that obtained from R, given
that 0.2514 is the closest approximation of 0.25 in the table.
```

C8. (2) Now use R to determine the value that represents the 97th percentile standard normal distribution, and the 97th percentile of a normal distribution with a mean of 5.8 and a standard deviation of 2.5 inches (distribution of January precipitation from lecture 7 practice problems). Return you R code and the solution.

```
> qnorm(0.97, mean=0, sd=1)
[1] 1.880794
> #and the 97th percentile of a normal distribution with a mean of 5.8 and a
standard
> #deviation of 2.5 inches (distribution of January precipitation from lectur
e 7 practice problems). Return
> #you R code and the solution.
> qnorm(0.97, mean=5.8, sd=2.5)
[1] 10.50198
```

We can also produce random draws from our common distributions using the "r" version of each function (e.g., rnorm), where "r" is for random. Look at the help file for this function and create a histogram of 10000 random draws from the standard normal distribution:

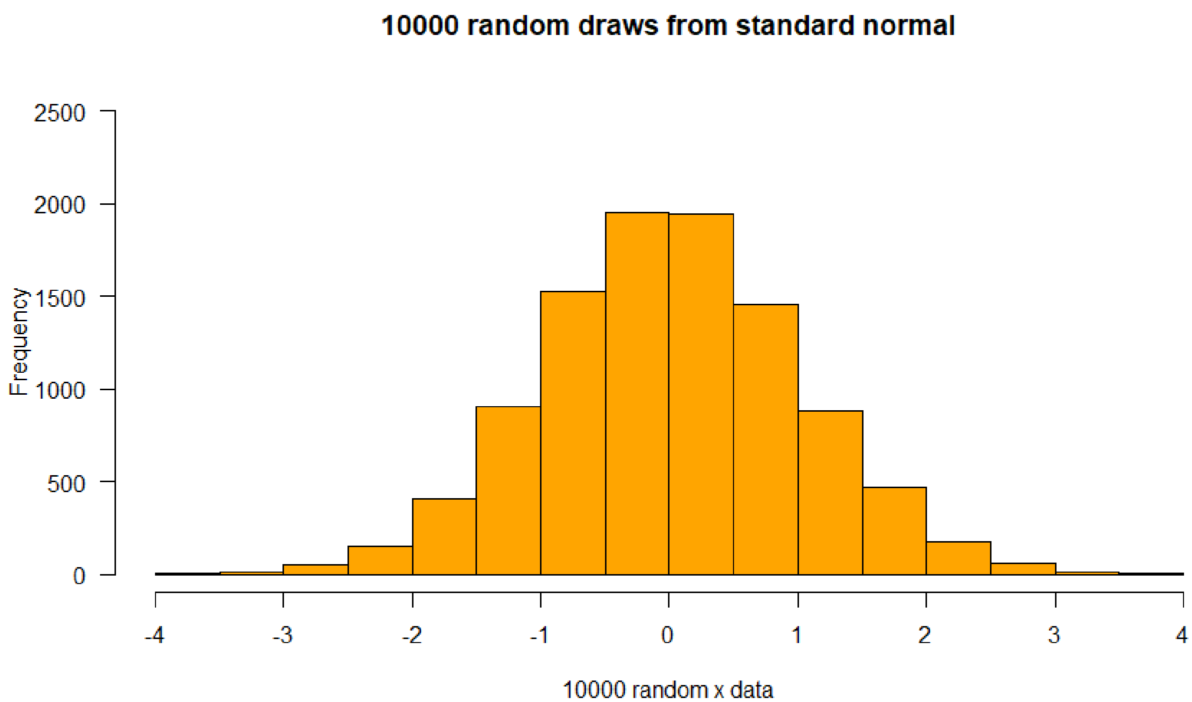
```
> help(rnorm)
```

Returns the information regarding the function.

page break

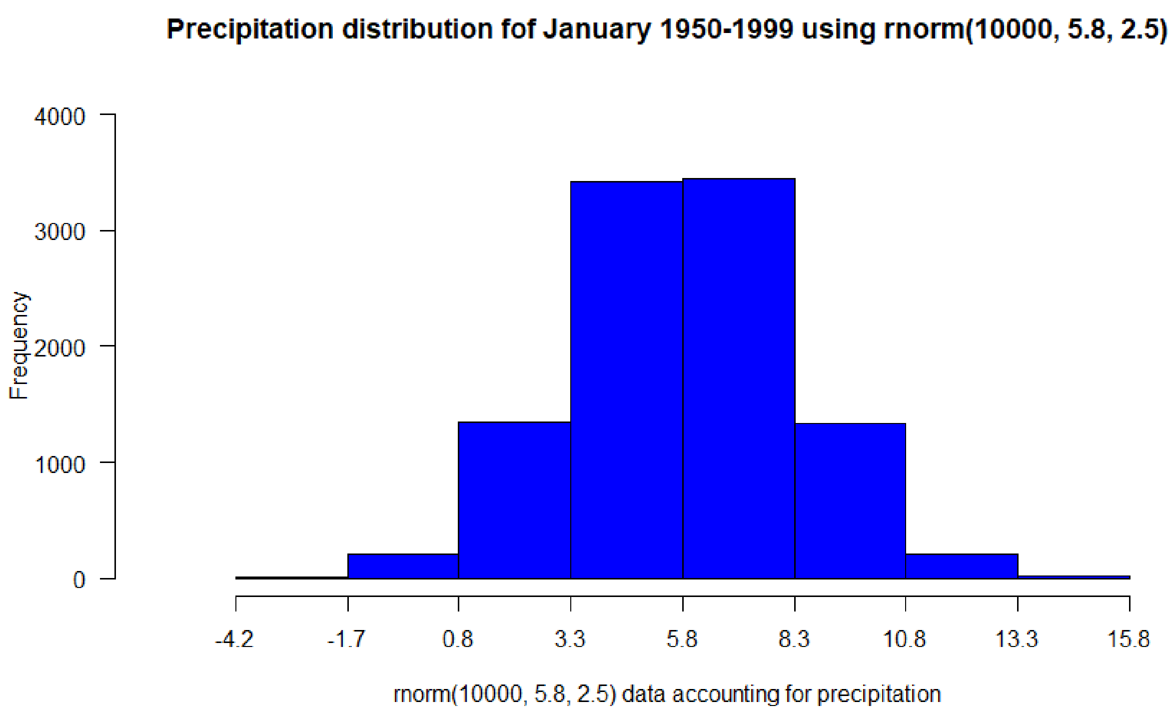
C9. (1) X~N(0,1). Copy and paste the histogram into your report.

```
# reset the plotting window to include only one plot
> par(mfrow=c(1,1))
> #Creating 10000 random draws
> #From a normal distribution with mean 0
> #And standard deviation sigma 1
> #Assigning it to var x.random=rnorm(10000,0,1)
> x.random = rnorm(10000, 0, 1)
> #mgp specifies the lines in the margin at which the
> #axis label, axis tick marks, and axis line are drawn
> # las=1 ensures that axis numbers are aligned in the reading direction
> # mar is for space round histogram
> par(mar=c(5,5,5,0), mgp=c(3,1, 0),las=1)
> #main argument writes a title
> #xlab labels x-axis
> #xlim sets the maximum and minimum values displayed on the x-axis
> #ylim sets the max and min values to be diplayed on y-axis
> #col sets the color
> #xaxp sets the tick marks on the x-axis
> hist(x.random,
+      xlab ="10000 random x data",
+      xlim = c(-4, 4),
+      xaxp = c(-4, 4, 8),
+      ylim = c(0, 2500),
+      col="orange",
+      main="10000 random draws from standard normal")
```



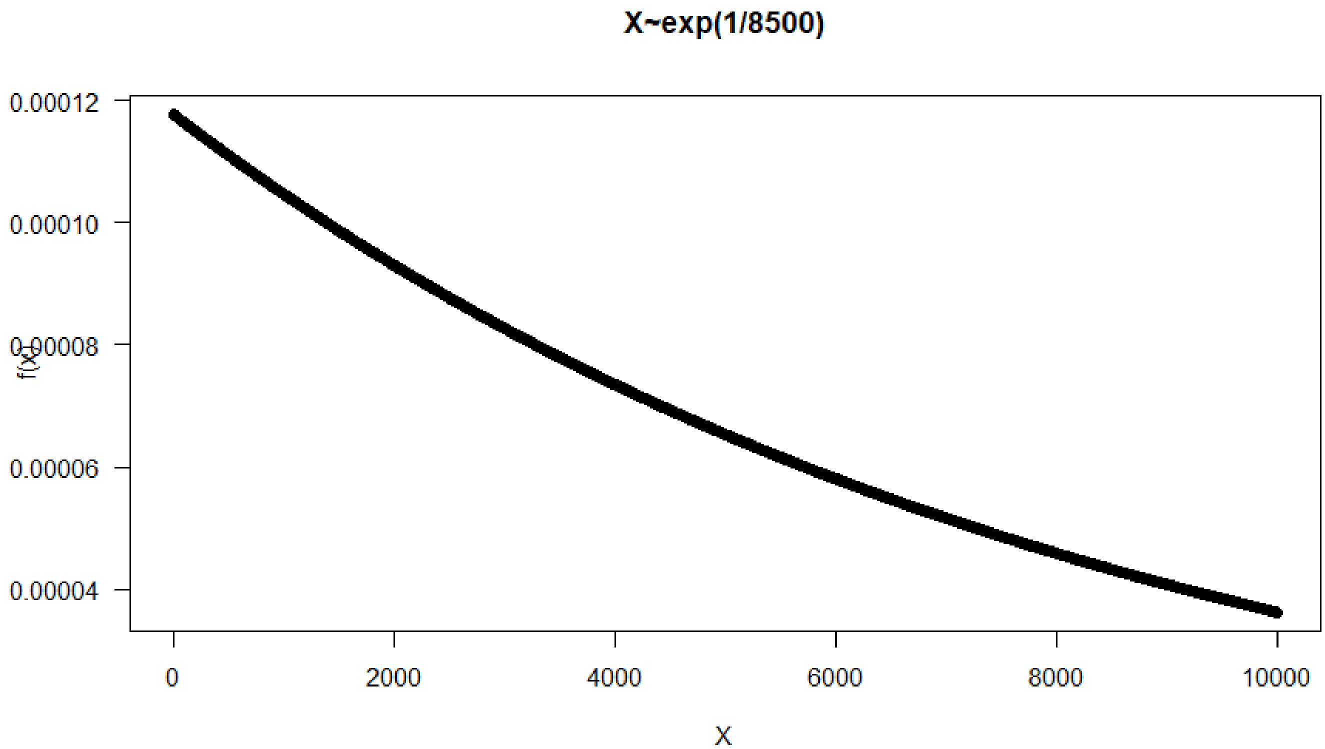
C10. (1) Now produce a histogram of random draws from the distribution of January precipitation.

```
#C10. (1) Now produce a histogram of random draws from the distribution of Ja
nuary precipitation.
> #X~N(5.8,2.5)
> #Same command as above, same purpose.
> par(mfrow=c(1,1), mar=c(5,5,5,0), mgp=c(3,1, 0),las=1)
> #Creating 10000 random draws
> #From a normal distribution with mean 5.8
> #And standard deviation sigma 2.5
> #Assigning it to var x.prec=rnorm(10000,5.8,2.5)
> #xaxp helps set tick marks of the histogram at 2.5
> x.prec = rnorm(10000, 5.8, 2.5)
> hist(x.prec,xlab ="rnorm(10000, 5.8, 2.5) data accounting for precipitation
",
+       xlim = c(-6, 17),
+       breaks = seq(-4.2,15.8, 2.5),
+       xaxp = c(-4.2, 15.8, 8),
+       ylim = c(0, 4000),
+       col="blue",
+       main="Precipitation distribution fof January 1950-1999 using rnorm(100
00, 5.8, 2.5)")
```



C11. (1) Use the function pexp to sketch the exponential distribution where λ = 1/8500.

```
create a sequence of x values starting from 0, ending at
> # 10000, by 0.1
> x.vals=seq(0,10000,0.1)
> # now create a vector of y-values which is the exponential
> # density function evaluated at those value of x
> y.vals=dexp(x.vals,rate=1/8500)
> # now graph:
> plot(x.vals,y.vals,xlab="X",ylab="f(x)",main="X~exp(1/8500)")
```



C12. (1) Using R, what is the probability x<1000 where x~exp(1/8500)? Return the solution and your R code in your lab document. Hint: use pexp.

```
#C12. (1) Using R, what is the probability x<1000 where x~exp(1/8500)? Return
the solution and your R
> #code in your lab document. Hint: use pexp.
> pexp(1000, rate = 1/8500)
[1] 0.1109902
```

C13. (1) Using R, what is P(1000<x<10000) for this exponential distribution? Return the solution and your R code in your lab document.

```
#C13. (1) Using R, what is P(1000<x<10000) for this exponential distribution?
Return the solution and
> #your R code in your lab document.
> pexp(10000, rate=1/8500) - pexp(1000, rate=1/8500)
[1] 0.5806446
```

C14. (1) Using R, produce a histogram of 10000 random draws of an exponential distribution with a mean of 1/8500 events per hour. Hint: use rexp.

```
hist(rexp(10000, rate=1/8500),xlab ="rexp(10000, rate=1/8500) data values", x
lim = c(0, 80000), ylim = c(0, 5000), main="Histogram distribution for rexp(1
0000, rate=1/8500)")
```