Script for R Demonstrations
Oct. 2

```
## Setup

#function for plotting Normal distributions
normal = function(mu,sigma){
 z = (-4000:4000)/1000
 x = mu + sigma*z
 Density = 1/(sigma*sqrt(2*pi)) * exp(-z^2/2)
 plot(x,Density,type="l")
}
#like above, but overlays on existing plot (e.g. histogram)
Normal = function(mu,sigma,s){
 z = (-4000:4000)/1000
 x = mu + sigma*z
 Density = 1/(sigma*sqrt(2*pi)) * exp(-z^2/2)
 lines(x,Density*s)
}

#function to plot Standard Uniform distribution
uni = function() plot(c(-.5,0,0,1,1,1.5),c(0,0,1,1,0,0),
  ty='l',xlab='x',ylab='Density',ylim=c(0,1.5))

#function to generate random numbers from a bimodal #distribution
rbimodal = function(n) rnorm(n)+round(runif(n))*8-4

#function to plot the above bimodal distribution
bimode = function(){
 x = (-8000:8000)/1000
 Density = 1/(sqrt(2*pi))/2 * (exp(-(x+4)^2/2)+exp(-(x-4)^2/2))
 plot(x,Density,type='l')
}

#function to plot (modified) chi-square distribtion
chisq = function(d,s) lines((1:5000)/1000,(pchisq((1:5000)/1000*d,d)-
  pchisq((0:4999)/1000*d,d))*1000*s)

#miscellaneous setup
par(mfrow=c(2,1))
M=0
M1=0
M2=0
M3=0
M4=0
M5=0
M10=0
M30=0
M100=0
M1000000=0
s=0
bad_s=0
```

```
sigma=sqrt(1/12)

##Distribution of Sample Means
normal(0,1)
X = rnorm(5)
X
mean(X)
rnorm(5)
rnorm(5)
mean(rnorm(5))
mean(rnorm(5))
mean(rnorm(5))
for(i in 1:10000) M[i]=mean(rnorm(5))
hist(M,30)

##Reliability of the Sample Mean
par(mfrow=c(2,2))
normal(0,1)
rnorm(5)
mean(rnorm(5))
mean(rnorm(5))
mean(rnorm(5))
for(i in 1:10000) M5[i]=mean(rnorm(5))
hist(M5,30)
SE5 = sqrt(var(M5))
SE5
rnorm(10)
mean(rnorm(10))
mean(rnorm(10))
mean(rnorm(10))
for(i in 1:10000) M10[i]=mean(rnorm(10))
hist(M10,30)
SE10 = sqrt(var(M10))
SE10
mean(rnorm(100))
mean(rnorm(100))
mean(rnorm(100))
for(i in 1:10000) M100[i]=mean(rnorm(100))
hist(M100,30)
SE100 = sqrt(var(M100))
SE100
mean(rnorm(1000000))
mean(rnorm(1000000))
mean(rnorm(1000000))
mean(rnorm(1000000))
mean(rnorm(1000000))

##Central Limit Theorem
uni()
runif(1)
runif(1)
runif(1)
```

```
for(i in 1:10000) M1[i]=mean(runif(1))
hist(M1,30)
runif(2)
runif(2)
for(i in 1:10000) M2[i]=mean(runif(2))
uni()
hist(M2,30)
for(i in 1:10000) M3[i]=mean(runif(3))
uni()
hist(M3,30)
for(i in 1:10000) M4[i]=mean(runif(4))
uni()
hist(M4,30)
for(i in 1:10000) M5[i]=mean(runif(5))
uni()
hist(M5,30)
for(i in 1:10000) M10[i]=mean(runif(10))
uni()
hist(M10,30)
for(i in 1:10000) M30[i]=mean(runif(30))
uni()
hist(M30,30)
Normal(.5,sigma/sqrt(30),100)
par(mfrow=c(2,2))
hist(M1,30)
hist(M2,30)
hist(M5,30)
Normal(.5,sigma/sqrt(5),200)
hist(M30,30)
Normal(.5,sigma/sqrt(30),100)
par(mfrow=c(2,1))

#now do the same thing with a bimodal distribution
bimode()
sigma = sqrt(17)
for(i in 1:10000) M[i]=mean(rbimodal(1))
hist(M,30)
for(i in 1:10000) M[i]=mean(rbimodal(2))
bimode()
hist(M,30)
for(i in 1:10000) M[i]=mean(rbimodal(3))
bimode()
hist(M,30)
for(i in 1:10000) M[i]=mean(rbimodal(4))
bimode()
hist(M,30)
for(i in 1:10000) M[i]=mean(rbimodal(5))
bimode()
hist(M,30)
for(i in 1:10000) M[i]=mean(rbimodal(10))
bimode()
hist(M,30)
```

```
for(i in 1:10000) M[i]=mean(rbimodal(30))
bimode()
hist(M,30)
Normal(0,sigma/sqrt(30),2000)

##Distribution of Sample Variances
normal(0,1)
X = rnorm(5)
var(X)
var(rnorm(5))
var(rnorm(5))
var(rnorm(5))
for(i in 1:10000) s[i] = var(rnorm(5))
hist(s,30)
chisq(4,2000)
mean(s)
bad_var = function(X) sum((X-mean(X))^2)/length(X)
for(i in 1:10000) bad_s[i] = bad_var(rnorm(5))
hist(s,30,breaks=(0:30)/5)
hist(bad_s,30,breaks=(0:30)/5)
mean(bad_s)
```