1. Rolling a die.

```
> x = c(1,2,3,4,5,6)
> probx= c(1/4,1/8,1/8,1/8,1/8,1/4)
> F16=sample(x, size=1500,  replace=T, prob=probx)
```

   (a) Describe what each `R` command is peforming in the above.

   (b) Using the `mean` and `var` command find the mean and variance of `F16`. From this information alone what would you conclude is the range of the random variable `F16`.

   (c) Does the mean and variance from the sample generated compare closely with the true mean and variance of `F16`.

2. Tossing a coin 10 times.

```
> b1 = rbinom(100,10,0.5)
> b2 = rbinom(100,10,0.25)
> b3 = rbinom(100,10,0.75)
```

   (a) Using the `?rbinom` explain what each of the above commands is performing in `R`

   (b) Using the `mean` and `var` command find the mean and variance of `b1,b2,b3`. Compare them with the true mean and variance of the Binomial distribution.

3. `geom_hist` command.

```
> library(ggplot2)
> df1=data.frame(b1)
> p11= ggplot(df1) + geom_histogram(mapping=aes(x=b1), color="black", fill="NA", binwidth=1)
> p21= ggplot(df1) +
+         geom_histogram(mapping=aes(x=b1, y=..density..), color="black", fill="NA", binwidth=1)
```

   (a) Explain what are the plots p11,p21 providing.

   (b) Rewrite the code to provide the plots for `b2` and `b3`.

   (c) What can you say about the three plots ?

4. Density Approximation. The below code plots the function `density` fin the interval $(0, 10)$ with $a = 5, s = \sqrt{2.5}$ along with the plot `p21`.

```
> library(ggplot2)
> density = function(x,a,s){ (1/((2*pi)^(0.5)*s ))* exp(-(x-a)^2/(2*s^2))}
> df1=data.frame(b1)
> p21= ggplot(df1) +
+          geom_histogram(mapping=aes(x=b1, y=..density..), color="black", fill="NA", binwidth=1) +
+          xlim(0,10) +
+          geom_function(fun=density, args=list(a=5,s=(2.5)^(0.5)))
```

   (a) From the picture what does $\int_3^6 \texttt{density}(x, 5, \sqrt{2.5})dx$ approximate ?

   (b) If

$$\text{Area under the histogram between 3 and 7} \approx \int_a^b \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{x^2}{2}\right) dx,$$

   then what would be your guess for a and b

(c) How would you try the same idea for `b2` and `b3` ? Would you get the same result ?

5. (Sums of Rolls) Suppose we wish to simulate in R the experiment that we did in class last week of Rolling a die and noting down its sum. We can use the `sample`, `matrix` and `apply`.

```
> x = c(1,2,3,4,5,6)
> probx= c(1/6,1/6,1/6,1/6,1/6,1/6)
> Rolls=sample(x, size=1500,  replace=T, prob=probx)
> Rollm=matrix(Rolls, nrow = 5)
> Rollsums = apply(Rollm, 2, sum)
```

(a) Describe the commands `matrix` and `apply`

```
> library(ggplot2)
> density = function(x,a,s){ (1/((2*pi)^(0.5)*s ))* exp(-(x-a)^2/(2*s^2))}
> dfrolls = data.frame(Rollsums)
> mu = mean(dfrolls$Rollsums)
> sigma= sd(dfrolls$Rollsums)
> ggplot(data=dfrolls) + geom_histogram(mapping=aes(x=Rollsums,y=..density..), color="#00846b", fill=NA, binwidth=1) + xlim(5,30)+geom_function(fun=density, args=list(a=mu, s= sigma), color="blac
```

(a) From the picture what does $\int_{12}^{21} \texttt{density}(x, mu, sigma)dx$ approximate ?

(b) If

$$\text{Area under the histogram between 12 and 21} \approx \int_a^b \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{x^2}{2}\right) dx,$$

then what would be your guess for a and b